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Functional analysis of prismatic blades and bladelets from Pinson Mounds, Tennessee

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ABSTRACT

Hopewell prismatic blade industries are a standardized technology but not a specialized one. Exactly why they are ubiquitous and synonymous with Hopewell is a puzzle. That Hopewell prismatic blade technology satisfied basic tool needs concurrent with efficient usage of toolstone are beyond dispute. Prismatic blades from Pinson Mounds and other Hopewell sites in the Midwest and Southeast United States were simple, easily repaired, modular tool forms of variable usage. This functional evaluation of 125 artifacts documents far distant preferential exploitation of prismatic blade toolstone sources within the Ohio River valley and its tributaries, reveals statistically significant differences among seven technological types, explicates a production chain model for burins, and argues that prismatic blade technology had an equal or greater social meaning and identity as a quintessential symbol of the Hopewell Interaction Sphere.

1. Introduction

This analysis is foremost a description of prismatic blade and bladelet function from Pinson Mounds, Tennessee. It complements Middle Woodland or Hopewell use-wear studies of Kimball (1992) for east Tennessee and North Carolina; Odell (1994) for Illinois; and the Ohio studies of Lemons and Church (1998), Miller (2014) and Yerkes (1990, 1994, 2003, 2009; see also: Yerkes, 1983, 1987; Lepper and Yerkes, 1997; Yerkes and Kardulias, 1993). Our study bridges between Semenov's (1964) traceological approach to the kinematics of tool use and Keeley's (1980) identification of worked (or contact) materials from distinctive use-wear polishes. These studies and ours depend almost exclusively on the use of experimental analogs in the microscopic identification of wear traces. But this study is not, nor was it intended to be, directly comparable to earlier studies.[1] In part, this is because it employs a far better microscope system—one with polarized light and Nomarski optics (Hoffman and Gross, 1970). And it also locates properly oriented mircroscopic observations on individual artifact imagery for ease in recognition of wear trace locations and functional divisions of tool elements. The cited studies, as well as ours, accept two basic analytical premises, namely that Hopewell prismatic blade industries are a standardized technology but not a specialized one, and that prismatic blade function is variable but largely unknowable in the absence of a use-wear evaluation. Clearly, additional functional analyses of Hopewell prismatic blades and bladelets are called for, as none of the published studies, including this one, fully documents the expectable range in tool function and materials worked at individual Hopewell sites.

Prismatic blade technology is ubiquitous and synonymous with Hopewell in eastern North America. Why this should be so remains a puzzle. Was it strictly a technological solution? That Hopewell prismatic blade technology satisfied basic tool needs concurrent with efficient usage of toolstone is beyond dispute. Yet we know appreciably less about Hopewell prismatic blade technological systems. They need to be understood on their own merits if we are ever to flesh out, first, inter regional variability in the Hopewell Interaction Sphere (Caldwell, 1964; Struever, 1964) and, second, as proxy indicators of underlying social and ideological foundations of this technology. Hence, this paper first outlines a functional evaluation of prismatic blades from Pinson Mounds and ends with our interpretation that prismatic blade technology had an equal or

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[1] Two peer reviewers reached similar conclusions about issues of analytical comparability but with decidedly different reactions. One said, "Their analysis is directed, clearly described, and extremely well illustrated. I wish I could take microphotographs of this clarity." The other opined, "In the photomicrographs in your ms., most of the images are out of focus. Striations are visible, but most of the micropolishes do not resemble the microwear on any published experimental Hopewell bladelets."

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greater social meaning and identity as a quintessential symbol of the Hopewell Interaction Sphere.

1.1. Pinson Mounds

One of the largest Middle Woodland mound groups, Pinson Mounds is located in west Tennessee, about 15 km south of Jackson, in Madison and Chester Counties. Within this 160 ha (400 acres) mound complex are at least 13 mounds, a geometric earthen embankment, and contemporary short-term ritual activity areas (Mainfort, 1986, 1988a, 1996, 2013) (Fig. 1). A unique feature of the Pinson Mounds complex is the presence of five large, rectangular platform mounds.

The western portion of the mound group includes at least four mounds and a ritual activity area designated the Cochran site (Broster et al., 1980:31–36). A ramped rectangular mound with a height of about 10 m, Ozier Mound (Mound 5) is the second largest mound in the Pinson group. About 200 m to the south are the Twin Mounds (Mound 6), a pair of large, conjoined burial mounds. The complex stratigraphy and some construction features of the northern Twin Mound are reminiscent of roughly contemporary mounds in southern Ohio (Brose, 1988; Mainfort, 2013). Just to the east of the northern Twin Mound is the small, conical Mound 31.

Located at what often is perceived as the “center” of the mound complex, the largest mound, Mound 9, or Sauls Mound, stands about 22 m tall and is about 100 m in diameter, though the actual shape is rectangular (Mainfort, 2013:3). About 100 m east of Sauls Mound is Mound 10, a small, oddly shaped platform mound, and Mound 12, a small burial mound, is located 200 m southwest. Mound 24, 200 m to the northeast of Sauls Mound, may be a constructed earthwork, though more excavation is needed to ascertain this. One of five rectangular platform mounds (including Sauls Mound) at Pinson Mounds, Mound 15 is located about 580 m southwest of Mound 9 within a small peninsula above the South Fork Forked Deer River bottomlands. Nearly half of the bladelet sample comes from an area northwest of Mound 15 that is designated the Mound 14 sector. A small, circular embankment designated the “Duck's Nest” was constructed near the edge of the bluff about 400 m south of Mound 9. To the north of this embankment is another short-term ritual activity area—the Duck's Nest sector.

Mound 28, a large rectangular platform mound, is located about 1020 m east of Sauls Mound (“center to center”). South of Mound 28 is a geometric earthen enclosure that surrounds an area of about 6.7 ha (16.5 acres). This is one of a modest number of Middle Woodland geometric embankments in the Midsouth and Lower Mississippi Valley, and the form and siting of the Pinson enclosure point to ties with Ohio Hopewell (Mainfort, 2013). Within the enclosure is Mound 29, a ramped rectangular platform mound. The irregularly shaped Mound 30 is located southeast of the embankment, near the edge of the bluff above the river bottomland.

Details about the Pinson Mounds complex and excavations conducted there appear in numerous publications (e.g., Mainfort, 1980, 1986, 1988a, 1996; Mainfort and McNutt, 2004; Mainfort and Walling, 1992) and are the subject of a recent book (Mainfort, 2013).

2. The prismatic blade sample

Following Tixier (1974), the Pinson Mounds sample of prismatic lamellar flake artifacts includes both blades (widths >12.0 mm) and bladelets (widths <12.0 mm) but is dominated by bladelets (88 of 125, or 70.4%) plus one object, a heat spall. The latter was misidentified initially and is not further considered. For convenience, the sample is referred to mostly as bladelets while recognizing that Tixier's distinctions may be too strict in this instance (Fig. 2). Blades and bladelets have been found in most excavated localities within the Pinson Mounds complex and were subjected to the use-wear analysis with two exceptions. These include the Cochran site area

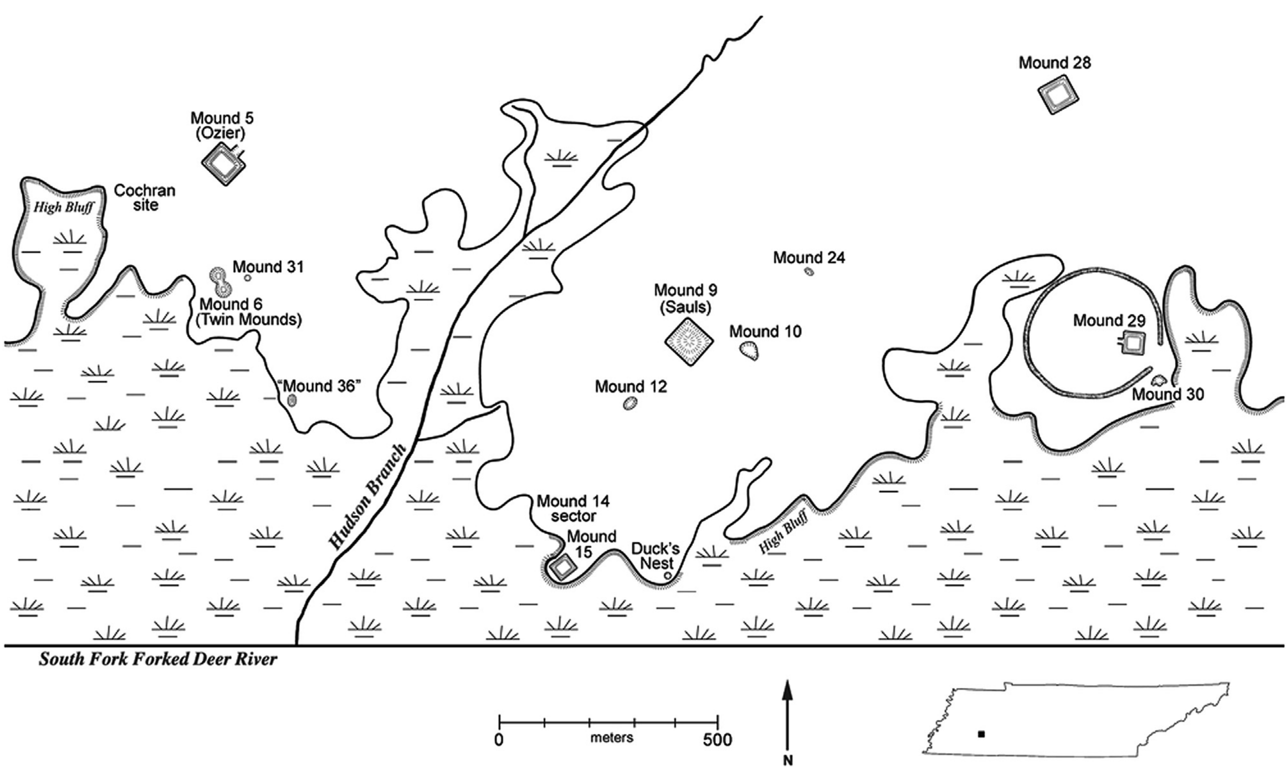

Fig. 1. Pinson Mounds, west Tennessee.

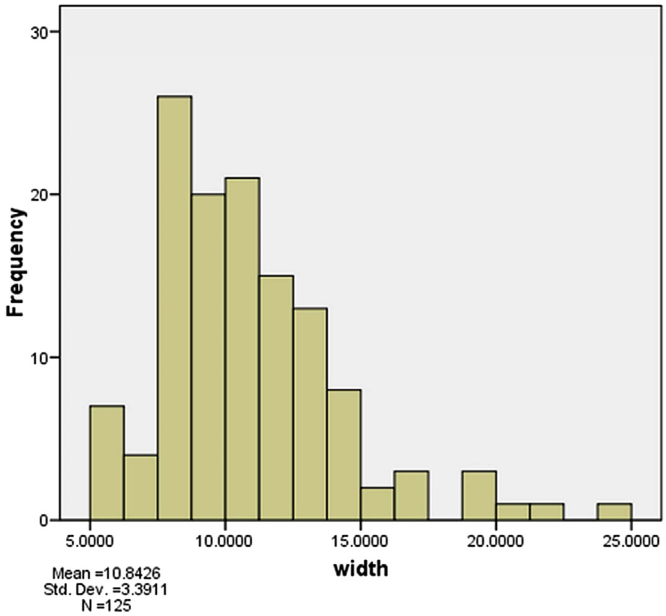

Fig. 2. Widths, in millimeters, of Pinson Mounds prismatic blades and bladelets.

($n = 16$), Ozier Mound ($n = 12$), the Ozier Mound sector ($n = 4$), the Duck's Nest sector ($n = 8$), the Mound 14 sector ($n = 59$), Mound 31 ($n = 7$), the Twin Mounds ($n = 5$), and the Twin Mounds sector ($n = 15$); two from the earthen enclosure area (the Eastern Citadel) were not analyzed.

During the 1993 “View from the Core” conference (Pacheco, 1996), Mainfort, N'omi Greber, and Robert Converse examined all the bladelets from Pinson Mounds that could be located in the collections. Some reported specimens could not be found (e.g., two from Mound 12; Mainfort, 1980:86). Mainfort, Greber, David Brose, and Mark Seeman examined some specimens during the 1984 Mid-South Archaeological Conference meeting at Pinson Mounds (Mainfort, 1988b). Of course, we are solely responsible for the identified raw materials used here.

Specific materials identified are as follows: 33 Flint Ridge chert, 20 probably or possibly Flint Ridge chert, 50 probably Fort Payne chert, 3 Wyandotte chert, and 2 possibly Upper Mercer chert. The remainder ($n = 20$) are made of cherts that resemble material in the debitage assemblage from Pinson Mounds (France, 1985) and probably are from the local area (including the Tennessee River valley). In Table 1, the column labeled “Flint Ridge?” includes specimens about which one or more individuals were uncertain about the raw material. “Fort Payne?” refers to specimens that fall within the range of chert debitage commonly seen at Pinson Mounds, but lack definitive characteristics of Fort Payne chert.

Though relatively small by Ohio Hopewell standards, the bladelet sample from Pinson Mounds is the largest among Middle Woodland sites in the Midsouth. Toth (1988: 96) correctly observed that “prismatic blades seem to be a good early Marksville marker” and reported specimens from a moderate number of sites in the lower Mississippi valley, including the Marksville site itself (Toth, 1988: 95–96, 98–99, 103–104, 106–107, 118, 165–168, 186–187). Many of these artifacts were produced from Cobden (Illinois) chert (Brookes, 1988: *x*). At Helena Crossing, Arkansas, Ford (1963: 44–45) found a group of eight Wyandotte chert bladelets at the shoulder of an interred adult. Excavations at the large Pharr mound group in northeast Mississippi yielded 35 “lamellar blades,” of which at least six were of Flint Ridge chert and two of Elkhorn (Kentucky) chert (Bohannon, 1972: 60–61). It seems noteworthy

Table 1
Bladelets from Pinson Mounds.

Area	Flint Ridge	Flint Ridge?	Wyandotte	Upper Mercer	Fort Payne	Fort Payne?	UID	Total
Cochran Site area	8	4			4			16
Ozier Mound	4	5			3			12
Ozier Mound sector		1			3			
Duck's Nest sector		1			7			8
Mound 14 sector	19	2	3	2	18	13	2	59
Mound 31	2	2			3			7
Twin Mounds		2			1		2	5
Twin Mounds sector		3			11		1	15
Eastern Citadel						2		2
Total	33	20	3	2	50	15	5	128

that no bladelets are reported from the extensive excavations at Bynum (Cotter and Corbett, 1951), some 90 km southwest of Pharr.

In object size and material sources, the Pinson Mounds sample is similar to other Midwestern finds from Hopewell sites, especially those from Ohio (Greber et al., 1981; Nolan et al., 2007; Yerkes, 1994) that are distinguished by bladelets from distant sources within the Ohio River drainage basin. A notable difference between Pinson Mounds and other reported sites (see also Odell, 1994) is potential intra-site contrasts in their distribution; at Pinson Mounds variation among blade and bladelet mean length, width and thickness is statistically insignificant for site area subdivisions, number and placement of dorsal facets, and raw material identifications. The Pinson Mounds sample is composed of mostly non-local (i.e., >25 km away) material (Fig. 3), and both crested blades indicative of initial prismatic blade production or core rejuvenation and others with variable numbers of parallel dorsal facets typical of later production stages are present. So, in this study, the Pinson Mound sample is regarded as singularly representative of the variation witnessed by an attenuated if not truly *local* Hopewell prismatic blade industry. It was one dependent upon non-local chert varieties and apparently lacking in prismatic cores, so blade production was seemingly not done at Pinson Mounds. This accords a certain simplicity to the assessment of artifact function, since at the outset we can dispense with concerns about raw material differences, flake morphology or specific site areas distinctive of either production or differential if not specialized blade usage at Pinson Mounds. The lack of prismatic cores at Pinson Mounds is typical of Middle Woodland sites in the Midsouth.

3. Analysis

The analysis employs a production chain approach, among the more robust ways to understand stone technologies and widely used (Bleed, 2001). The overall model is subtractive and linear in design (Fig. 4) and is intended to identify technological systems and the timing of task performance (Bleed, 1986) likely evident at Pinson Mounds. The use-wear approach, however, addresses facets of a technological production chain not as readily or unambiguously available by other means (Fig. 5); included are the delineation of functional types actually employed by the makers and users of prismatic blades plus the use history and potential utility of prismatic blades at Pinson Mounds.

The basic approach to the use-wear analysis is to first assess taphonomic factors such as trampling damage or soil movement. These instances of pseudo-wear are distinct from but can be confused with actual wear traces; they also provide information about the abandonment of artifacts or their post-depositional history. Next, use-wear provides direct evidence of stone tool usage, materials worked (i.e., contact materials) and decisions made about

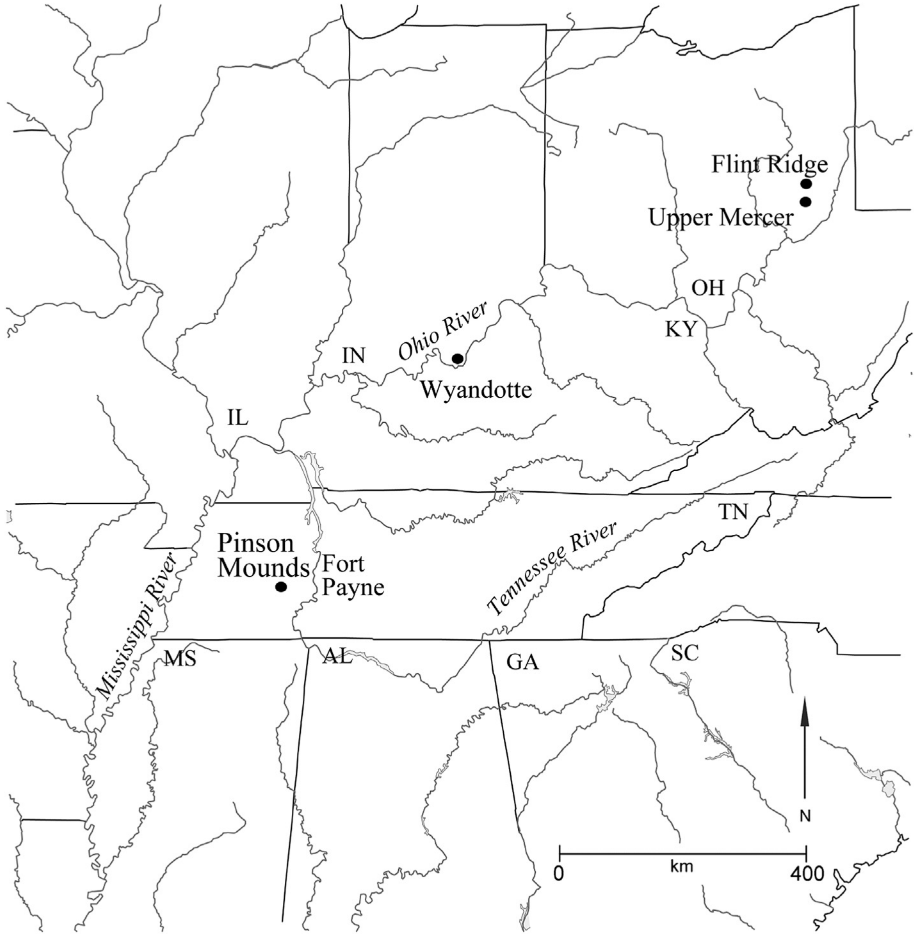

Fig. 3. Pinson Mounds prismatic blade material source distributions.

tool maintenance, recycling or discarding. These insights then can be compared with other technological and typological assessments and to further the understanding of the chipped stone tool production chain.

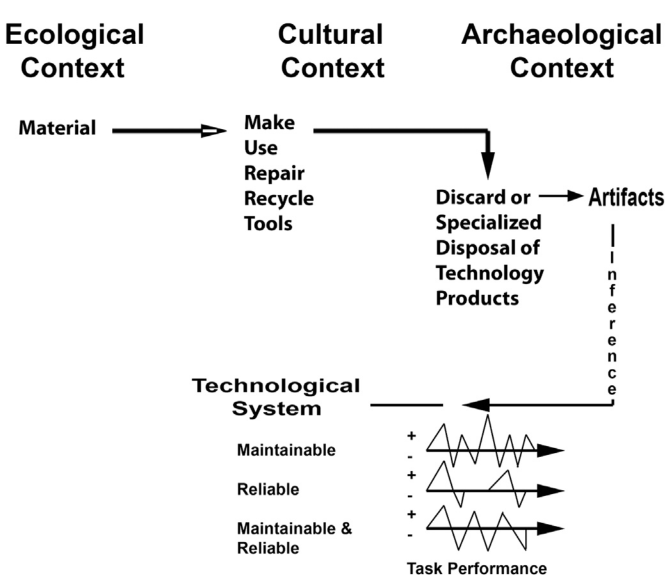

Fig. 4. Subtractive technology model, adapted from Kay (1984) and Bleed (1986).

At Pinson Mounds the prismatic bladelet wear traces are largely striated residues, or additive "microplating" features, that develop progressively with tool use (Kay, 1996, 1998) and record sequences of use as more-or-less complex palimpsests. Microplating residues are impervious to ultrasonic cleaning with concentrated strong bases (KOH) and acid (HCL), occur on siliceous artifacts from varied depositional environments, and ages in excess of at least 100,000 years. Experimentation demonstrates that microplating residues develop and harden coincident with tool use, are a biochemical byproduct of moisture and direct contact with a material worked by a stone tool or adhering to it, and in an elegant way express tool motion kinematics (or friction-related features of surface-to-surface contact). They exhibit flow characteristics of a viscous liquid, and desiccation cracks as they harden.[2] Microplating in-fills striations, becomes striated whenever abrasive particles strike, and crystallizes as brilliant white translucent filaments on the trailing (i.e., opposite from the) border of contact with a worked or manipulated material, and thus opposite the direction(s) of movement of a tool stroke. They are also instructive of hand-holding the tool or complementary movement of the tool in its handle. Microplating features are ubiquitous on the artifacts and overprint other tool use-related abrasion and abrasive wear traces.

[2] These wear traces ought to be among the more conspicuous attributes but they are rarely documented nor recognized (for an example of both see Plisson and Lompré, 2008:506 Photos 6–8).

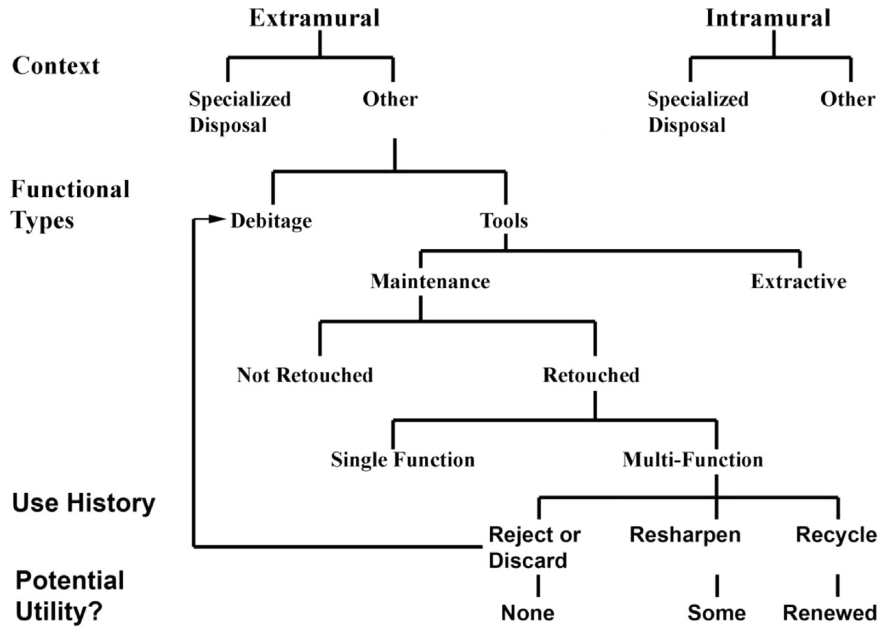

Fig. 5. Use-wear supported evaluations of lithic technology. Note for reasons of space the hierarchical relations illustrated only for extramural contexts would apply equally for intramural contexts. See Bleed (2001) for a general discussion of production chains; Binford and Binford (1966) for differences in tool function.

Microplates exhibit long-term stability, sensitivity to motion, and affect the microgeometry of a tool edge. Microplates bond to stone surfaces and edges as use continues. Experimental controls indicate hardening occurs coincident with use, or shortly thereafter. Unless deliberately removed, microplating so dulls an edge that it can no longer function. Microplates are among the more valuable wear traces.

Thus among the advantages of this analysis is to identify when a tool no longer had a usable edge plus the steps taken just before discard of spent tools. As judged from stone tool use experiments and archaeological examples (Kay, 1998; Kay and Martens, 2004; see also Banks, 2009:21), the initial tendency appears to have been to swipe with a finger or thumb the detritus from a tool edge that visibly is associated with poor performance. And to do so in a way to minimize cuts or injuries, one must swipe parallel to and away from the tool edge. The microscopic result is a striation or set of them that both roughly parallels the tool edge and crosscuts earlier striations caused by normal tool use. We refer to these telltale signs as cleaning strokes.

The use-wear analysis looks at wear traces indicative of use, hafting, optional maintenance, and possible contact materials—or substances with which a tool comes into direct contact. This report considers first technological and functional tool types, contact material identification, the comparison of tool edge placement and extent, and hafting indicators as reflections of tool use life and "serviceability" or —conversely— tool rejection and discard. It then addresses implications of the analysis for a broader understanding of prismatic blade technology at Pinson Mounds and more generally.

3.1. Data recording history and methods

Kay evaluated the 126 artifacts from Pinson Mounds in 1998 and summarized findings at the Society for American Archaeology 68th Annual Meeting in Milwaukee, Wisconsin in 2003. This paper is developed from his original 1998 notes, analog photographic records, and a computerized database; and stone tool using experiments before (for an insightful critique see van Gijn, 1990) and since (a representative but not exhaustive summary is Longo and Skakun, 2008).

Before analysis, the artifacts were cleaned, following Keeley's (1980:11) techniques. Then they were examined for wear traces by using a differential-interference binocular compound microscope with polarized light and Nomarski optics at magnifications ranging from 100 to 400 diameters. The evaluations systematically covered the edges and ventral surface of the artifacts, and took note of edge cross-sectional shape and damage. The ventral (interior) surface is the flatter of the two surfaces, generally would be the leading surface of a tool that is in direct contact with a worked material, and its wear traces are by definition subsequent to flake detachment. Wear traces were photographed and their position and orientation on the artifact were recorded on macroscopic photographs. Other details of the investigation were recorded in written notes for each artifact.

For macroscopic photography but not microscopic examination, artifacts were also "smoked" with water-soluble ammonium chloride to form a uniform, thin, white coating. Under oblique light, this coating shows flake scar patterns and edge damage. Simple immersion in water dissolves the ammonium chloride. Observations about edge damage, tool edge placement and extent, and hafting indicators were also recorded on macroscopic photographs.

Prismatic blade edge angles were measured with a magnifying reticle protractor to the nearest five degrees from the profile of each artifact. Other linear measurements were recorded with Vernier calipers to the nearest 0.5 mm; mass, to the nearest 0.000 g with a digital balance.

4. Technological and functional tool types

Analyses of variance (ANOVA) of sample means individually for length, width, and thickness of technological types identified by the use-wear analysis reveals statistically important differences among them ($p < 0.000$). These results are unlikely to be due to chance selection. They emphatically support the argument that seemingly subtle differences in blade form differentiate tool function. For illustrative purposes, this variation is shown as a box-

and-whiskers plot for the intra-quartile ranges of lengths for these technological types (Fig. 6) that includes tool elements, waste byproducts (debitage), and likely candidates for further tool production (blanks).

Debitage and blanks had no wear traces, other than ones attributed to taphonomic processes; object size distinguishes the two. Pinson Mounds debitage accounts for 11 items (8.8%) and is consistent in being the smallest in length of the bladelet fragments, too small either to be easily held or effectively attached to a handle. So the bladelet debitage represents a waste byproduct, a discarded reject. The debitage could be either a result of failure in initial bladelet production or tool maintenance by a deliberate snapping, or radial fracturing, of the bladelet (Crabtree, 1977) and which resulted in the discarded fragment.

Pinson Mounds blanks number 35 items (28%) and mostly fall within the size ranges of the bladelet tools (see Fig. 6). They may well have been held in reserve for later conversion into one of several prismatic bladelet tool forms or had technological flaws and proportions that ultimately led to their rejection and discard.

The remaining 79 (63.2%) Pinson Mounds prismatic bladelets all have tool wear traces and comprise five general functional types. Some tools had multiple tool edges for different purposes. The multifunctional tools are discussed in whichever major category seems most appropriate. There is no hard and fast rule that governs their placement, although whenever possible the initial tool use takes precedence. The most common bladelet tool is the burin, which accounts for 42 artifacts (33.6%). And Insofar as 12 burins have two tool edges and an additional one has three, the actual emphasis on burins per se is underestimated by their total numbers. Other tool edges and with comparable edge angles are in the same position as the bladelet burin tools (Fig. 7). As discussed later, these might well constitute the initial step in the burin production chain for Pinson Mounds. At Pinson Mounds burins were used to gouge, slot, or engrave mostly hard materials such as wood, bone or antler. Technically speaking, these would all be fabricating or maintenance tools. With one exception, Pinson Mounds burins differ in overall form and mode of

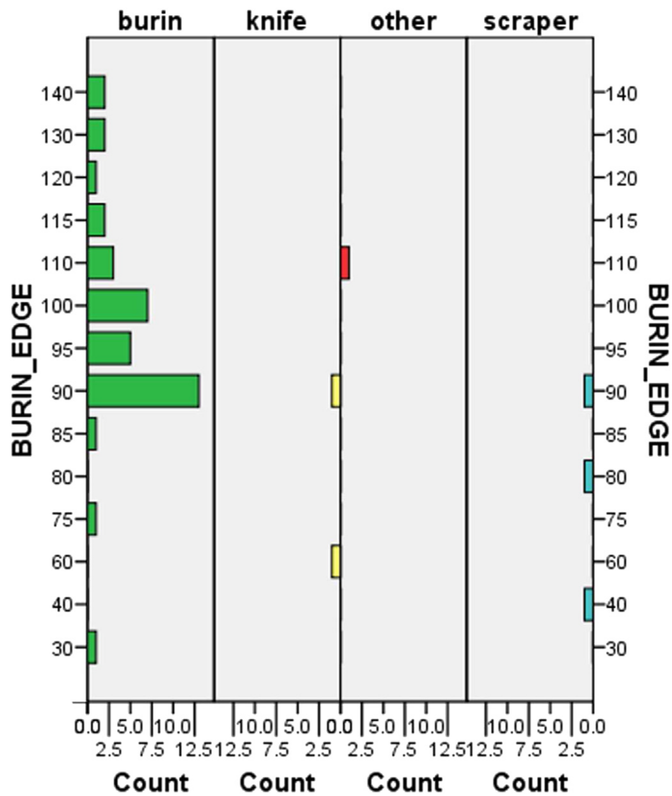

Fig. 7. Burin edge angles for burins and other bladelet tools at Pinson Mounds. Data bars alternate from left to right, then right to left for clarity in identifying tool functional fields.

manufacture from the classic Upper Paleolithic dihedral burins and others with a clear burin facet. Most constitute burins on snapped or radial fractured ends (Crabtree, 1977; see also Root et al., 1999:150–151); the smaller pieces left from this process

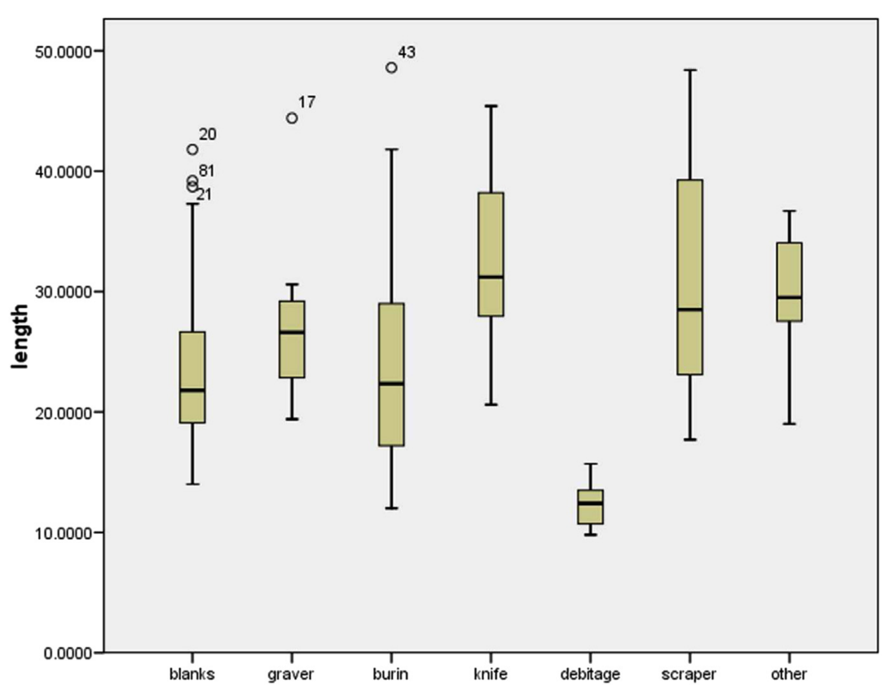

Fig. 6. Box-and-whiskers plots of lengths in millimeters of technological classes identified by the use-wear analysis for Pinson Mounds.

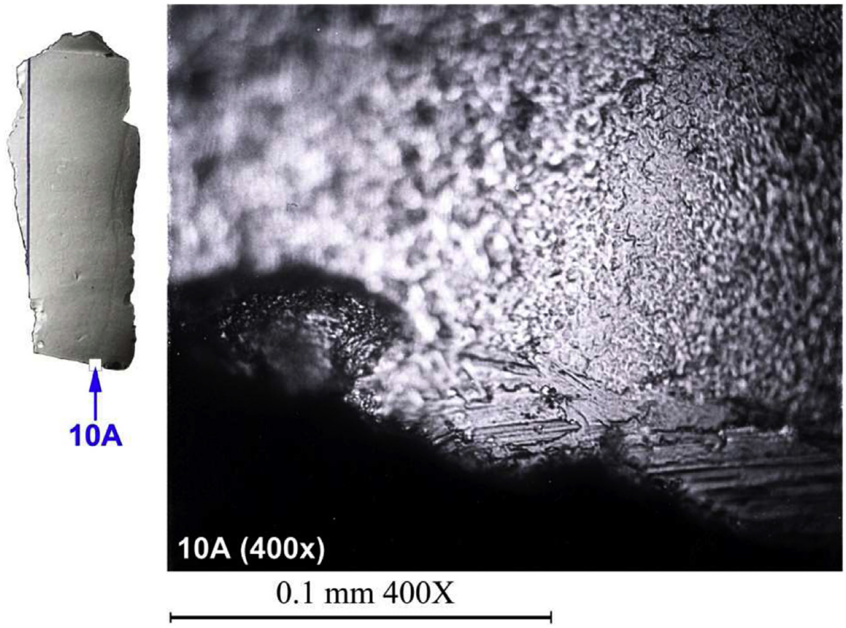

Fig. 8. Oriented photomicrograph of slotting burin use-wear on the ventral side of snapped proximal end of Pinson Mounds bladelet 10. Note the cupped-out damage that truncates, on the left, the tool edge and the consistent orientation of striations along the densely striated microplated edge. The microplating extends across the tool edge and forms a narrow band (i.e., the "contact zone") adjacent to the edge only. This polish is most similar to experimental results of slotting soaked antler.

would be debitage as discussed earlier.[3] The fractured ends tend to have sharp and durable right- to obtuse- edge angles (Fig. 7). They are also easily repaired by further snapping or radial fracture of an end. Undoubtedly, the vast majority of burins (36 or 85.7%) met this expectation, as they are bladelet fragments. A related tool form, the graver, accounts for an additional seven (5.6%) bladelets. These have one pointed end and acute tool edge angles. The knife category is distinct in usage of an acutely angled lateral edge or edges to cut parallel or transverse to the edge and is represented by 11 (8.8%) bladelets. The scraper tool form accounts for 12 (9.6%) bladelets with a slightly curved and acute to nearly right angled tool edge; the prime tool stroke is transverse or perpendicular to the tool edge. The final tool category, other, includes seven (5.6%) bladelets and consists of two tools distinct in function from all others, three with haft wear evidence only, and two others with possible haft wear. As discussed later, two of the three with haft wear only are described with the burin category.

4.1. Burins

Burins are of two general kinds, slotting or gouging. In either case, the wear traces tend to form a narrow band (or contact zone) adjacent to the tool edge and are non-invasive. The tool edge is often chewed up or highly damaged and a source of abrasive particles even while its overall original cross-sectional shape is maintained as a near right angle edge. Slotting burins display wear traces (Fig. 8) conspicuous for consistent orientation of striations parallel or slightly oblique to the tool edge; striation numbers tend to be high and densely distributed. Experimentation shows similar features in creating a groove in soaked wood, bone or antler by running the tool edge parallel to the intended groove and with the adjacent tool edges in progressive contact with the surfaces of the groove as the groove deepens. The striation density of slotting burins tends to increase with contact material hardness and is especially noteworthy for antler. In contrast, gouging burins have wear traces (Fig. 9) with striations inconsistent in orientation or both perpendicular and transverse to the tool edge in an overall more random appearance; striation numbers tend to be variable but often significantly less than for slotting operations. Experimentation shows these wear traces to be a byproduct of scooping out a cavity in relatively hard material by a process of progressive nibbling away at the surface and further broadening of the cavity. The force of a slotting burin stroke concentrates evenly along the entire tool edge length, much as when a woman wearing a high heeled shoe telescopes force to the heel. But, in a gouging burin, force is less well distributed and is more likely to snap the tool edge if improperly applied.

Given the increased likelihood of failure and discard, that the majority of burins were used to gouge or scrape is not surprising. Seventeen (40.4%) were single-edge gouging burins, six (14.2%) double-edge, three (7.1%) single-edge gouging and slotting burins, and two (4.7%) double-edge gouging and slotting burins. One was a gouging burin on one end and a scraper on the other; another, a gouging burin on one snapped end opposite a slotting burin on the other and on one lateral edge a knife. Three (7.1%) were single-edge slotting burins and two (4.7%) double-edge slotting burins. Of the remaining seven, six were identified simply as burins and one as a burin and a graver.

Cleaning strokes occur on tool edges of 12 (28.5%) burins and, as noted earlier, are indicative of final, failed attempts to maintain the edge. This number is the most conservative estimate of burin tool edge failure and rejection. We regard it as likely to be a gross underestimate, however, of burin discard rates.

Cleaning strokes are found on five single-edge gouging burins, three double-edge gouging burins, and on both ends of a double-edge burin used to gouge and slot and also used as a knife; cleaning strokes occur too on individual single-edge burins used to gouge and slot, to slot, and both to gouge and scrape. This does not seem to demonstrate a strong preference for cleaning one burin

[3] Kimball (1992) is, to our knowledge, the first to make this connection for Hopewell prismatic blades. Our independent results and those of Yerkes (2009:115) are a further confirmation.

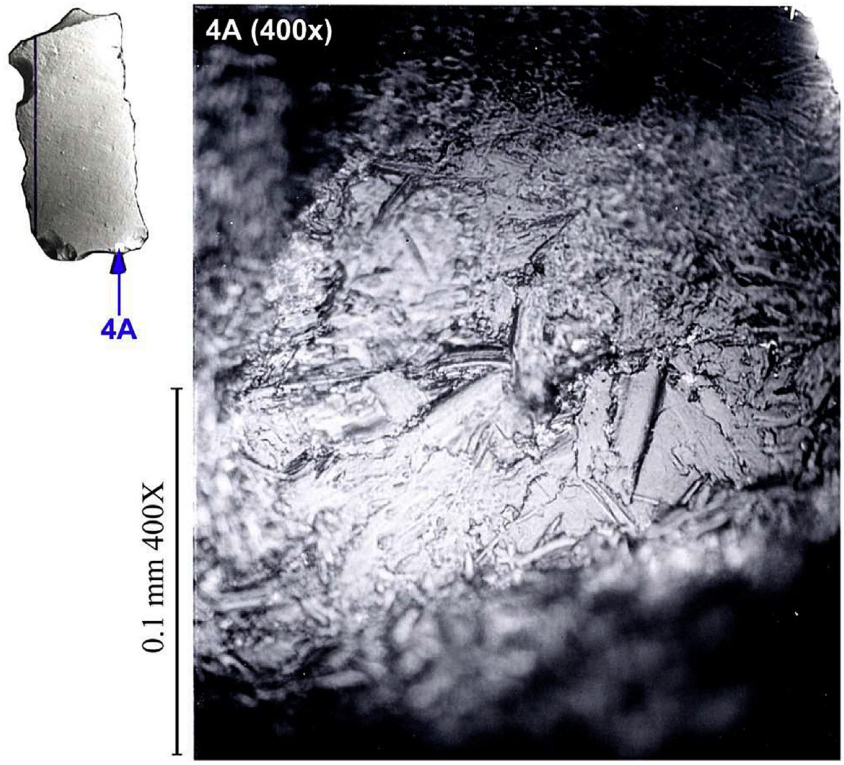

Fig. 9. Oriented photomicrograph of gouging burin use-wear on the ventral side of snapped proximal end of Pinson Mounds bladelet 4. Note the irregular tool edge, its microplated coating and slightly broader contact zone than for Fig. 8, and the more-or-less random orientation of striations. This edge was not repaired and its state is indicative of a dulled and unserviceable tool. In overall appearance this polish approximates closely those produced experimentally in working soaked bone.

form or another, although the incidence of cleaning strokes decreases with the number of tool edges. The illustrated examples (Fig. 10) of two burin edges on opposite snapped ends of bladelet 14 are especially good in showing how the cleaning strokes parallel the tool edges and crosscut earlier burin wear. Note also the infilling of slotting striations and that the microplating extends completely over the two tool edges.

A better approximation of burin discard rates might be to compare the lengths of burins with cleaning strokes and those lacking them, as total length would be the critical variable in any attempt to sharpen a burin by the simple act of radial fracture or snapping the blade. In making this comparison, the four smallest burin lengths (from 12.0 to 14.8 mm) are for tools lacking cleaning strokes followed by one each (at 16.3 mm long) with and without a cleaning stroke. From that point on the lengths of burins with or without cleaning strokes simply dovetail each other, and the largest burin length (at 48.6 mm) is for one with a cleaning stroke. Two implications are: that those smaller than 16.3 mm in length were simply too short to be further maintained, and that burins with a minimum length of 16.3 mm to a maximum length of 48.6 mm would have had about an equal likelihood of being either further maintained or rejected and discarded. Evidence of possibly successful burin edge maintenance identifies three (7.14%) tools only, all bladelet fragments that lack burin wear but have haft wear traces (discussed later); these are 16.3 mm, 25.5 mm, and 25.7 mm in length.

Seemingly in support of this idea too are two of three bladelet tool elements that have hafting wear only and are classed in the category, other. Reconstructed haft lengths are 25.13 mm, and 26.54 mm, which compares favorably with the three candidates for burin edge maintenance, just described. One has a snapped distal end and the other is complete. Either or both might well be examples of successful burin edge maintenance too.

It may not be unreasonable to assume the 39 other burins are mostly if not totally spent tools.

Nineteen (45.2%) burins were attached to handles and display diagnostic hafting wear traces. Haft wear traces result from nearly imperceptible movement of the tool in its binding, not necessarily or not always a failure to properly stabilize the tool. The key to haft wear traces is emphatic evidence of —if only— slight movement of the tool, and seemingly as it was being used, in areas away from the tool edge. Relative to prehension, or hand-holding a tool, the net result is haft wear traces are often well developed or expressed and generally show motion opposite or transverse to that of the tool edge. Hafting wear traces tend to be invasive, are indicative of surface-to-surface contact or binding lashings, and often are opposite or adjacent to but without overlapping tool edge wear. They may display secondary effects of tool use, although it is not always possible to make this distinction.

Fig. 11 is one example for a gouging burin (82A) in which the haft wear traces (82-B2) originate from the left lateral edge as viewed from the ventral surface, adjacent to the tool edge, but extending along its entire length (also micro photographed at 82C but not illustrated here). Both the striated microplatings and the large abrasive particle that caused one striated furrow are oriented slightly oblique to the tool's longitudinal axis and pointing away from the tool edge. In addition, crystallization filaments and spots are on both sides of the striations, which indicate bidirectional back-and-forth movement. The kinematics of hafting in this instance would seem to be entirely consistent with the gouging burin edge wear, and the reconstruction of force directed to this edge noted previously.

The general tendency for hafted burins was to encase the tool so that only the tool edge was exposed. This provided greater stability and reduced the likelihood of loosing much of the bladelet length

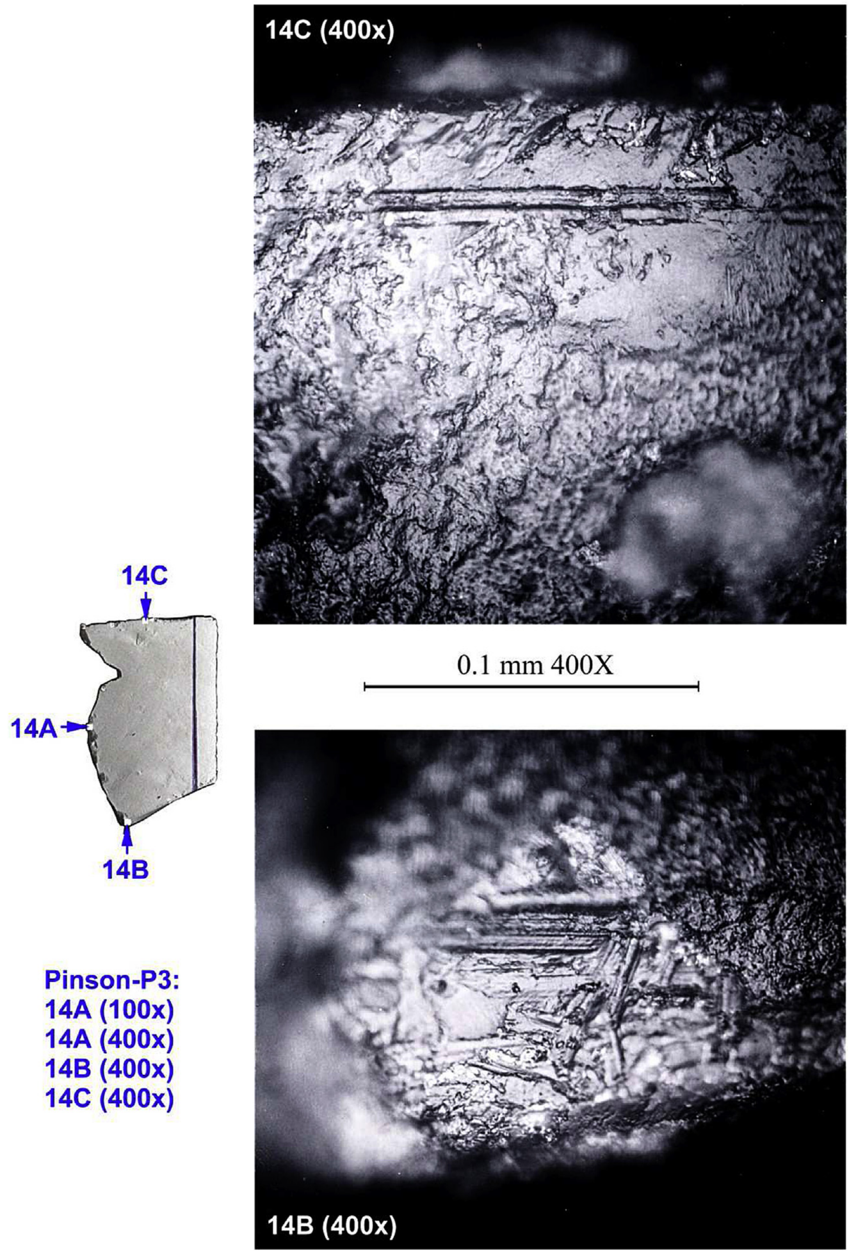

Fig. 10. Oriented photomicrographs of cleaning strokes on ventral side of both slotting (14c) and gouging (14B) burin tool edges for Pinson Mounds bladelet 14. Note the microplating faceting of the 14C edge. Contact material is inferred to be soaked bone or antler. Now go back and examine Fig. 8 and note the cleaning stroke there.

should the tool edge snap in use. Bladelet length would have been the critical factor in extending a burin's use life, as the operating principle would seem to have been to sharpen a dulled burin edge by the simple act of radial fracture or a bending snap. This process when applied to a prismatic bladelet would recreate the original snap burin tool edge form in a single, simple operation that conserved overall bladelet length. So the process could be repeated for either a hand-held or hafted burin.

Burins constitute the majority of the hafted tools (19 of 30, 63.3%). Their haft lengths are variable but largely satisfy the proportional requirement to house the bladelet so as to provide maximum protection to overall bladelet length. Fig. 12 shows contrasting overall configurations of haft length for all hafted tools. It is clear that the functional differences among them carried over to hafting technological considerations and the overall engineering design of the tools.

It is difficult to uniformly characterize burin and other tool contact materials. Tool edge microgeometry; striation density, placement of and orientation; and microplating attributes all differentiate contact materials, although not perfectly. The most conservative approach is simply to regard these as indicators of relative hardness. On an ordinal scale of soft to hard, scraping soft materials tends to round tool edges while hard materials tend to break them, or they remain relatively angular to subangular in cross-section. A difference between soft plant and hide processing is the character of the polish that develops at and near a tool edge. Herbaceous plant polish tends to be bright and with a melted appearance. And this applies to a large degree for polish due to contact with harder wood too, but with fewer striations. Hide polishes tend to have a dull or matt-like appearance and a rough texture, which may separate plant from hide work.

Working hard materials results in exceedingly narrow (or at the immediate edge only) bands of non-invasive tool edge contact.

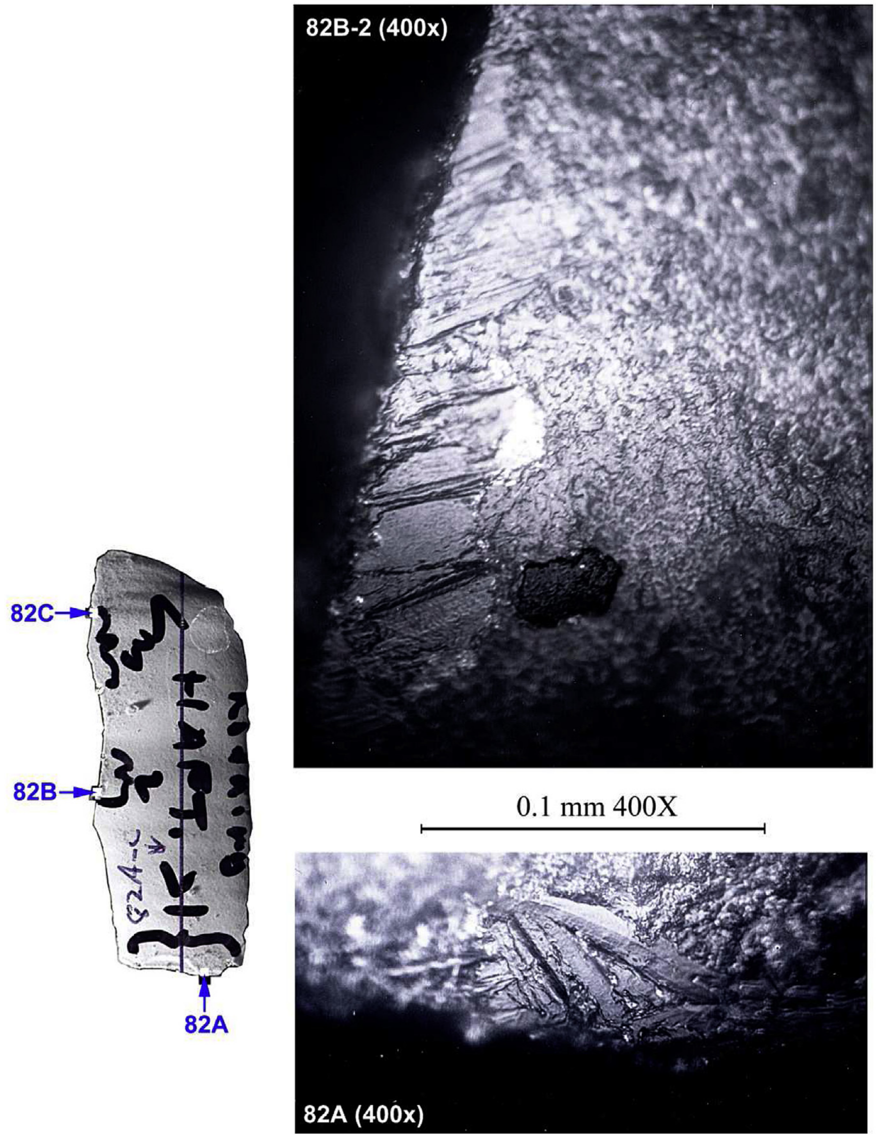

Fig. 11. Oriented photomicrographs of haft wear traces (82B-2) on a gouging burin (82A). The tool edge was not repaired and its state is indicative of a dulled and unserviceable tool.

Along with this narrow contact zone, tool edge failure is common so that the edge becomes chewed up or clearly micro damaged by cupped out pits or step fractures (Figs. 8 and 9). The tool edge, however, often largely maintains its overall original, near right angle cross-sectional shape (Fig. 10[14C]). As use progresses, the contact between a worked material and the tool surface often becomes microplated, as is generally true for Pinson Mounds. When dealing with hard contact material, this microplating buildup may smooth and fill in microtopography along the tool edge causing its flattening or faceting (Figs. 10[14C] and 11[82B]). Working less hard material, or what might be termed medium hard material, results in somewhat more invasive contact and a broader contact zone, accompanied by greater edge attrition if not actual edge rounding; edge rounding may become accentuated with microplating and dull the edge (Fig. 13). Soft material contact is pretty much the opposite and becomes highly invasive and with progressive tool edge rounding.

Contact materials for the majority of Pinson Mounds burins are judged to have been hard (25 or 59.5%), or a combination of medium hard to hard (2 or 4.7%); medium hard contact materials are inferred for 12 others (28.5%). As noted earlier, three others lack burin tool edge wear likely because the spent tool edges were removed when sharpened.

Translating hardness scales to actual contact materials is at best an inexact science dependent upon experiments in processing contact materials with stone tools. It seems likely the hard material contacts of Pinson Mounds burins would have been mostly bone or antler but also may have included dense, hard, deciduous wood; the medium hard contact material, less hard deciduous or coniferous wood.

4.2. Gravers

The seven, single-graving tips are all unprepared, natural projections of the distal ends of the bladelets, and likely were selected on an ad hoc basis. The tips are all damaged. None appears to have been successfully repaired. One was attached to a handle. And another might have been but the critical evidence is obscured by labeling on the ventral side. The others all display no evidence of hafting, and probably were hand-held. The wear traces relate only

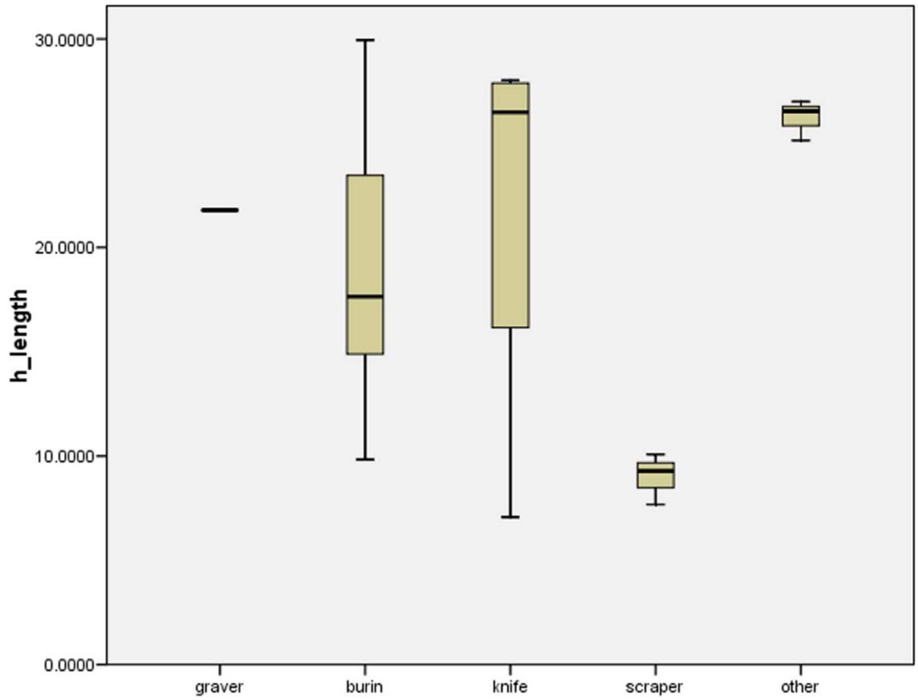

Fig. 12. Box-and-whiskers plots of haft lengths in millimeters of technological classes identified by the use-wear analysis for Pinson Mounds. (Frequencies hafted: graver $N = 1$, burin $N = 19$, knife $N = 4$, scraper $N = 3$, other $N = 3$).

to the damaged, unrepaired graving tips on all specimens. These fall into three general categories.

The most common occurs on five gravers and is usage in slotting and both a push–pull and then a rotary motion; or more precisely a back-and-forth, twisting motion for these hand-held tools (Fig. 14). The tool stroke would have been a combination of engraving and boring. The contact zone is fairly narrow and local to the tip only, and there is slight microplated edge rounding along with microplate smearing. Some smearing might be cleaning attempts if not true cleaning strokes, but we were simply unsure of this. On balance a medium hard to hard contact material would seem responsible for this graver wear such as hard wood but not ruling out soft stone, shell or even fired ceramics.

Engraving or slotting wear is evident on the hafted graver (Fig. 15). Its tool edge is badly damaged or chewed up and has an exceedingly narrow contact zone. It resembles burin slotting wear traces. In this instance the graver tip most likely engraved a shallow line or lines in relatively hard material, perhaps bone or antler or another material of equal hardness. The direction of tool motion, or stroke, parallels the edge and appears to be from right to left as crystallization filaments are on the left side only.

Narrower still is the contact zone on the final graver, a hand-held tool, but with a difference (Fig. 16). The contact zone follows a slight ridge that runs the breadth of the broad tip. It is microplated and striated, with the striation direction perpendicular to the ridge. A scraping tool motion is indicated for a hard contact material. This might have been a burnishing, or polishing tool.

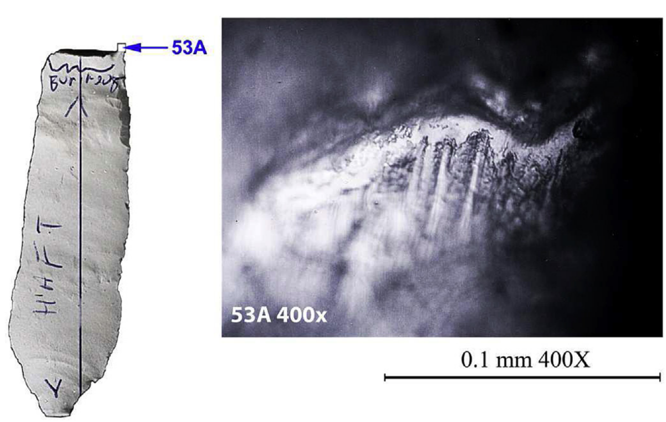

Fig. 13. Oriented photomicrograph of single-edge gouging burin, Pinson Mounds bladelet 53 ventral surface. Note microplating rounding of tool edge that in-fills striations perpendicular to it and abrasive particle on right part of the edge. Edge rounding of this kind is normally associated with medium hard materials and, in this instance, is likely a hard, deciduous wood polish. This edge was not repaired and its state is indicative of a dulled and unserviceable tool.

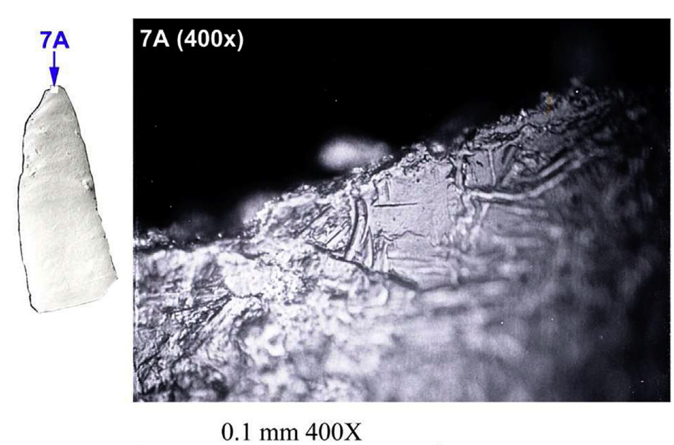

Fig. 14. Oriented photomicrograph for hand-held, ad hoc graver, ventral side of Pinson Mounds bladelet 7. Note the slight edge rounding and crystallization filaments just beyond the edge, the smeared microplating and in-filled striations that might relate to a final cleaning attempt. This tip was likely unserviceable at this point.

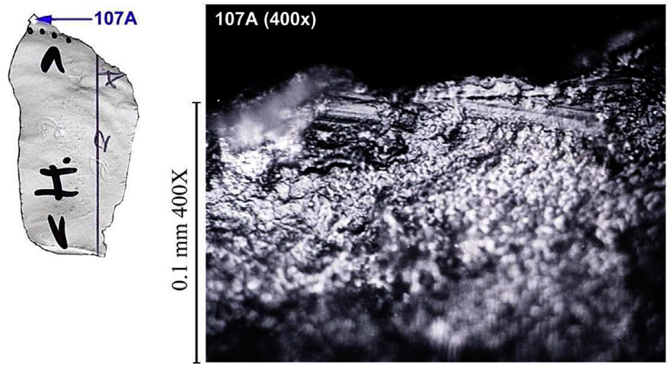

Fig. 15. Oriented photomicrograph for hafted, ad hoc graver, ventral side of Pinson Mounds bladelet 107. This tool was used to slot and the tool stroke was from right-to-left. Note the exceedingly narrow contact zone, the irregular edge profile and crystallization filaments on its left side. This edge was not repaired and its state is indicative of a dulled and unserviceable tool.

4.3. Knives

Knives fall into three general functional categories—soft herbaceous plant cutting, whittling deciduous wood or carcass butchery, and hard material slotting or gouging-scraping. Represented by two hafted bladelets, the final category shares many wear characteristics and tool edge placement with burins and gravers (Fig. 17). And indeed it could well be the initial production stage in the latter fabricating tools. Were these knives to be resharpened by a simple snap or radial fracture of an end, the net product would be indistinguishable from a burin. The other two categories involve invasive wear to differing degrees and variable placement of tool edges.

Accounting also for two bladelets, soft herbaceous plant cutting results in the most invasive material contact and, characteristically, a densely striated rounded tool edge and bright, luminous polish, or what Witthoft (1967) termed glazed polish and now described mostly as sickle sheen. Technically, these two bladelets (Figs. 18 and 19) would not be true sickles insofar as neither was hafted. But it is fair to say too that not all soft plant cutting tools required a handle. And these apparently did not. Both had a single lateral tool edge. The two differ in that one had a tool stroke parallel to the edge while the other was perpendicular and then followed by a cleaning stroke. Edge damage obscured or removed the sickle sheen from the former, so that its presence is entirely in the spot micro photographed. Even so, the striation orientation parallel to the lateral edge is typical of contact along the entire length of the tool edge. For the other, its entire knife edge had wear traces identical to that shown. In their present state, neither tool appears serviceable. Experimentation with soft plant cutting suggests the responsible plant contact material could have been a grass, a soft herbaceous plant, or a slightly harder reed.

The final knife category, seven in all, is a catchall group of whittling and/or carcass butchery. In this, we simply accept the ambiguity of likely contact materials when material identification is based strictly on soft to medium hard to hard contact wear traces. Our experience is to acknowledge a multiplicity of factors that confuse the issue and make differentiation between reasonable alternatives difficult if not impossible. Such is the case for Pinson Mounds.

In either whittling or carcass butchery the cutting stroke is likely to be dichotomized into cutting parallel to the blade edge (Fig. 20), or parallel and oblique to it (Fig. 21). The Pinson Mounds sample is dominated by the latter tool stroke that occurs on six of the seven tools. Two knives were attached to handles but differ in blade orientation: one was hafted lengthwise in a slot leaving the other lateral edge exposed, the other's distal end only projected from its handle much as with hafted burins. The five hand-held knives similarly display variability in tool edge placement. Two are similar in either causing or taking advantage of a notch in an unretouched edge, although they differ in that one is on a lateral edge and the other the distal end. Two others have two tool edges each, one on the opposing lateral edges and the other on the two ends. The retouched lateral edge on the final tool served as the knife edge.

One additional whittling or carcass butchery knife edge is on the double-ended burin with cleaning strokes (Fig. 10). The cutting wear striations are somewhat invasive, mostly parallel the tool

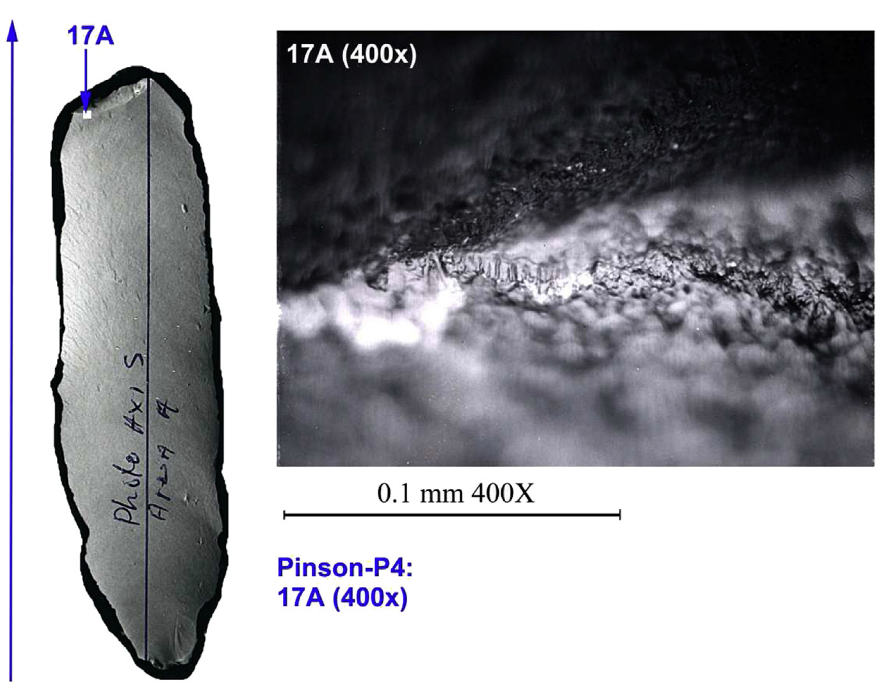

Fig. 16. Oriented photomicrograph for hand-held, ad hoc graver, ventral side of Pinson Mounds bladelet 17. This tool was used to scrape or burnish a hard contact material.

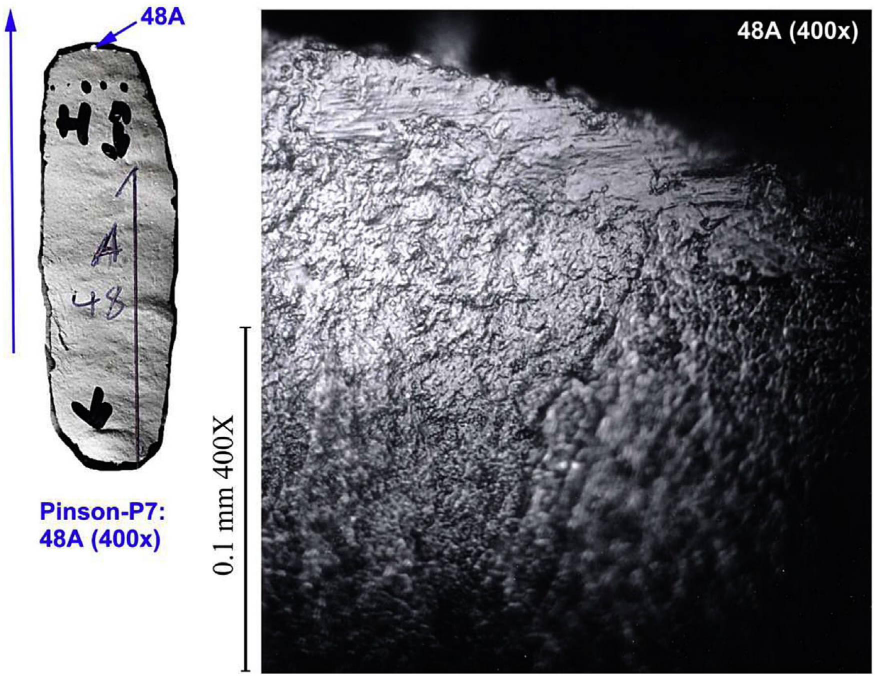

Fig. 17. Oriented photomicrograph for hafted knife, ventral side of Pinson Mounds bladelet 48. This tool was used to slot hard material and its wear traces are almost identical to those of slotting burins (see Fig. 8) and gravers (see Fig. 15).

edge, and are truncated by edge damage (Fig. 22). The latter undoubtedly led to rejection of the tool edge.

4.4. Scrapers

Scraper edge placement, contact material hardness and kinematics of use identify three functional subgroups and 12 scrapers. Tool edge rounding and wear trace invasiveness define the first functional subgroup – hide or soft wood scraping with unprepared edges, for four side and two end scrapers. None of scraping edges, however, is especially smooth and one of the end scrapers is somewhat jagged which is inconsistent with hide work, at least when the goal is not to further damage or cut the hide. The wear traces for five of six tools, while distinctive, are not especially

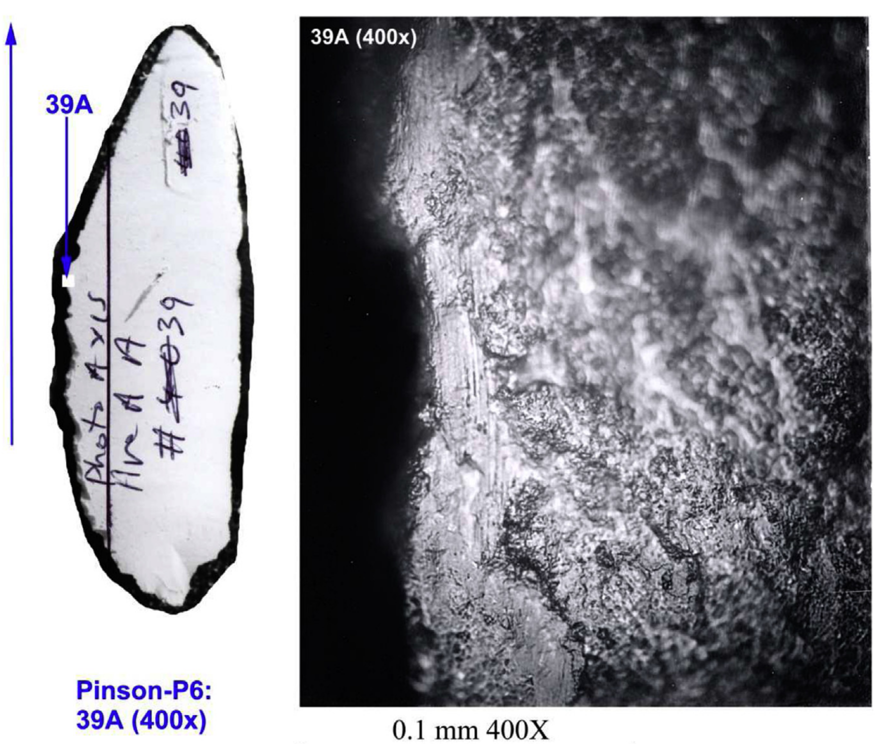

Fig. 18. Oriented photomicrograph for hand-held knife used to cut soft plant material, ventral side of Pinson Mounds bladelet 39.

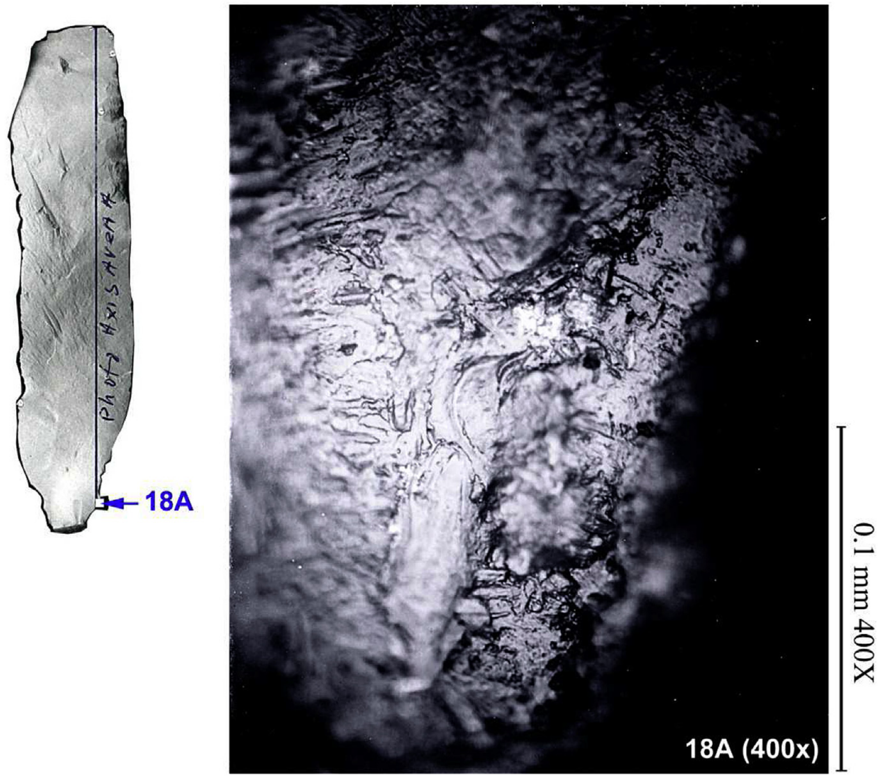

Fig. 19. Oriented photomicrograph for hand-held knife used to cut soft plant material, ventral side of Pinson Mounds bladelet 18. Note cleaning stroke of smeared microplating and semi-circular striations.

photogenic (Fig. 23), which is more typical of hide scraping experimental replicas; included are extensive edge rounding, microplate smearing and desiccation cracks, and filled-in striations perpendicular to the tool edge consistent with the bidirectional crystallization. A back-and-forth scraping tool stroke is indicated against a pliable, soft contact material. This subgroup includes two hand-held bladelets with individual scraping edges on the ends (one of which could be regarded as a proto-burin and has an edge angle of 40°), one hand-held bladelet with a right lateral (or side) scraping edge, and three with similar haft wear traces that show

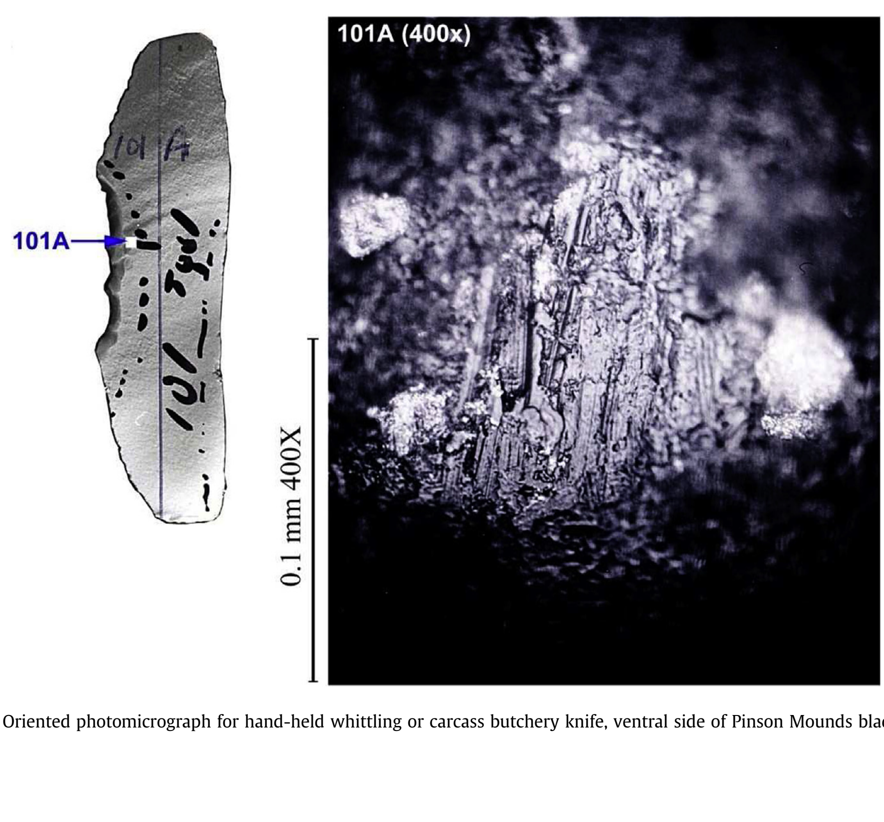

Fig. 20. Oriented photomicrograph for hand-held whittling or carcass butchery knife, ventral side of Pinson Mounds bladelet 101.

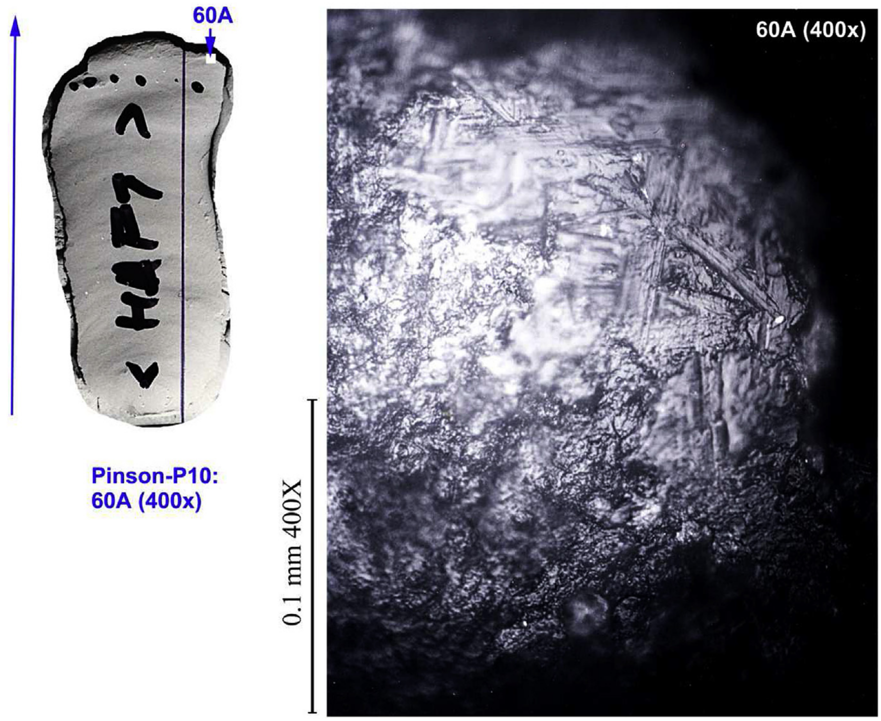

Fig. 21. Oriented photomicrograph for hafted whittling or carcass butchery knife, ventral side of Pinson Mounds bladelet 60.

the bladelet was placed lengthwise in a slot and exposed one lateral edge, the scraping edge. One of the latter is unique in its luminous polish and adhering spheroidal abrasive particles (Fig. 24). This is most similar to experimental working of herbaceous plants, reeds especially.

Four hand-held, ad hoc end scrapers comprise the second functional subgroup of less pliable scraping in a back-and-forth motion (Figs. 25 and 26). The wear traces are invasive, luminous and well developed. Overall contact material hardness would have varied less among them than the first functional subgroup. Three

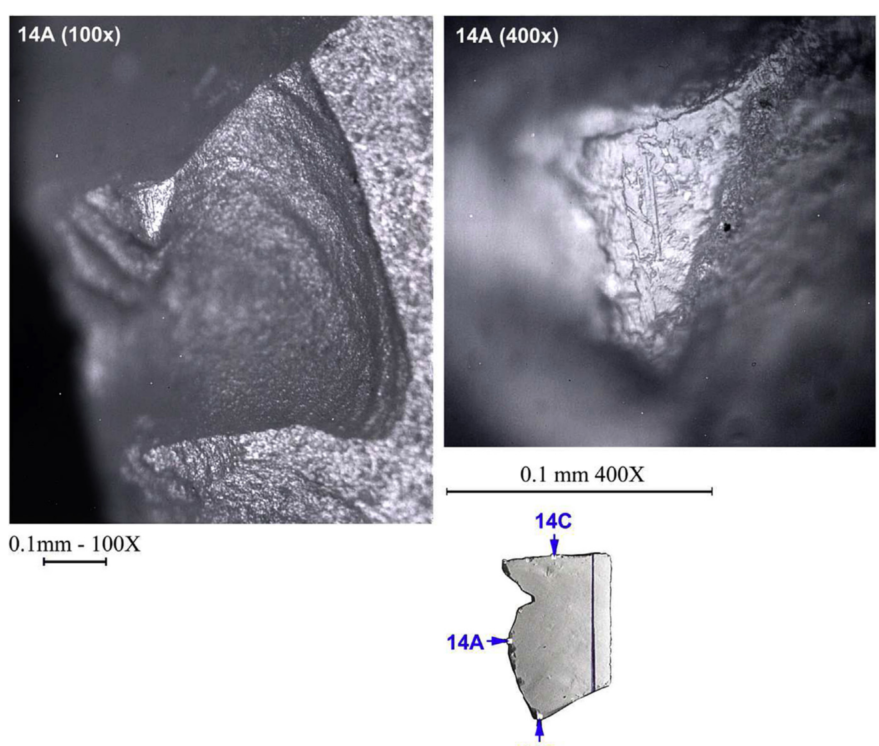

Fig. 22. Oriented photomicrographs for hafted whittling or carcass butchery knife edge, ventral side of Pinson Mounds bladelet 14. The deep “v”-shaped notch in this edge is likely post-depositional plow damage. See also Fig. 10.

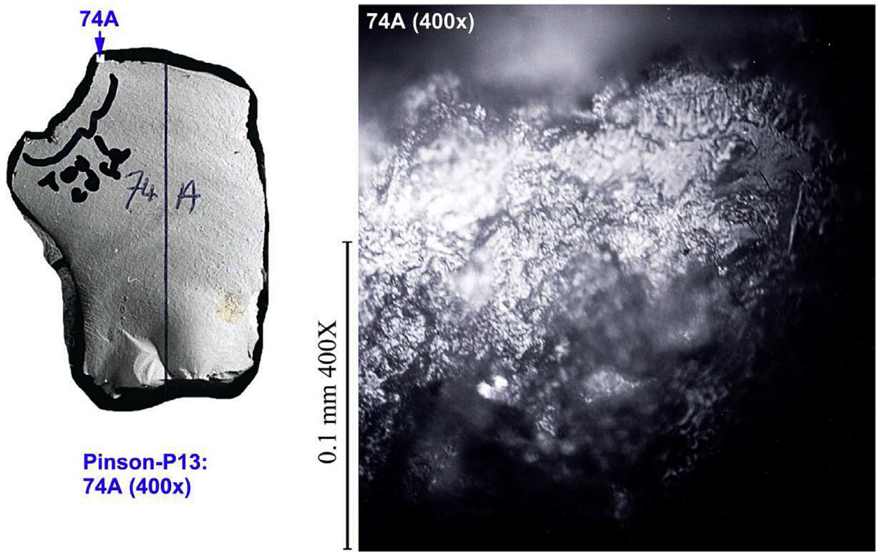

Fig. 23. Oriented photomicrograph for scraping soft contact material, ventral side of Pinson Mounds bladelet 74.

have no tool edge rounding and the fourth slight rounding. When considered in conjunction with wear trace invasiveness, the worked material would have had to have been yielding yet not fully enveloping the edge; more typical of medium hard contact materials. Wood or reeds are most likely, considering the bright, reflective quality of the microplating and experimental analogs. Two of the scrapers are on snapped ends and would be easily classed as potential snapped burins; their tool edge angles at 80° and 90° are fairly consistent with the snap burins too. The more steeply angled of the two has a second, lateral scraping edge, also true for one other scraper.

The third functional subgroup consists of two unprepared, hand-held scraper planes. These would have been mostly pushed across the surface of a worked material. Both took advantage of snapped, sharply angled distal ends, which experienced edge attrition but no rounding in use. As shown (Fig. 27), the striation orientation is uniformly oblique to the edge and has a high density. Use on either hard wood or possibly (but less certainly) bone or antler seems likely. The illustrated example has an unassociated graving spur (at 1) on a lateral edge too.

4.5. Other

The seven artifacts fall into three groups: three with haft wear but no obvious evidence of use (two of which are described above with the burins), two with possible haft wear only, and two with singular use histories.

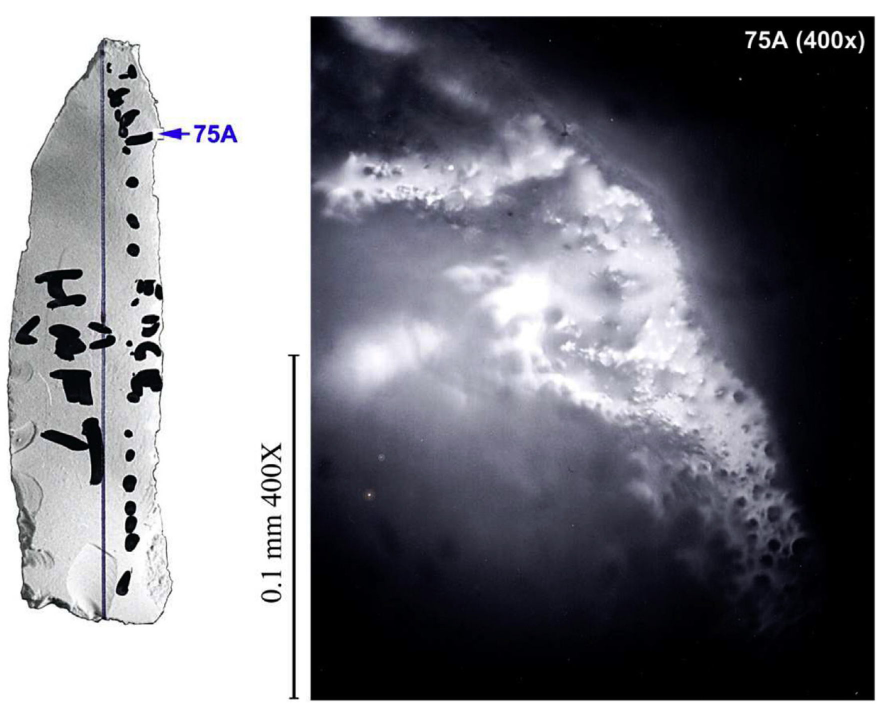

Fig. 24. Oriented photomicrograph for scraping soft contact material, ventral side of Pinson Mounds bladelet 75. This is most similar to experiments in scraping reeds.

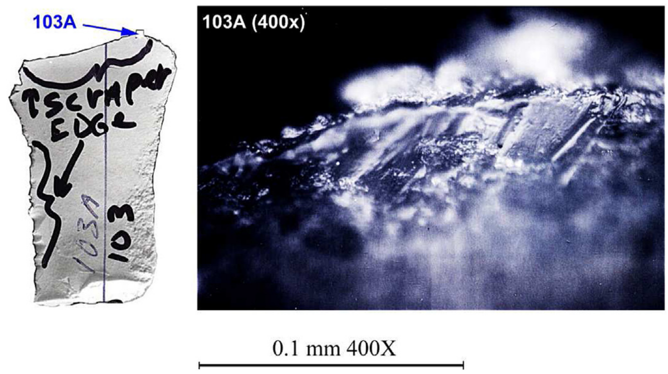

Fig. 25. Oriented photomicrograph for scraping medium hard contact material, ventral side of Pinson Mounds bladelet 103. Note slight edge rounding, striations oriented oblique to the edge, bidirectional crystallization filaments, and microplate smoothing or faceting.

The one remaining with definite haft wear only is a slender bladelet with a broken tip, or what might have been an ad hoc graving spur. Its dimensions are 29.5 mm length, 6.9 mm width, and 1.7 mm thickness. Haft wear extends from the proximal (striking platform) end almost to the tip; haft length is 26.99 mm. The tip is damaged but has no obvious use-wear, so it may have snapped in use as a graver.

A proximal bladelet fragment has a metal streak at the broken, snapped end; this is likely due to plowing. And, while it appears to have been hafted originally, it is impossible to reliably separate the post-depositional taphonomic effects from any evidence of hafting.

The other bladelet, a distal fragment snapped at the proximal end, has no use-wear on the proximal snap or the lateral edges. It does, however, have surface abrasion normally seen with hafting and at the distal tip what might well be haft wear (Fig. 28). The possible haft wear is microplated with filled-in striations oblique to the longitudinal axis and also parallel to the edge, and abrasive particles. Labeling on the ventral side, unfortunately, obscures some of the possible surface abrasion and makes it impossible to measure potential haft length. Its dimensions are 36.7 mm length, 10.5 mm width, and 2.6 mm thickness. Although not certain, this artifact might be a snapped burin that underwent successful tool edge sharpening without further use.

Unique tool elements include a distally notched bladelet with dimensions of 25.7 mm length, 9.2 mm width, and 3.7 mm thickness and a complete crested blade with dimensions of 33.2 mm length, 16.5 mm width, and 5.4 mm thickness. Both are probable wood working tools, used once and not repaired.

The former took advantage of the notch itself, which has extensive, well developed wear traces (Fig. 29a) opposite what could be hafting or prehension wear (Fig. 29b). Insofar as no other potential haft wear is on the lateral edges and ventral surface, we favor prehension wear but acknowledge it could equally be due to cutting a hard material, most likely shell (see Yerkes, 1983:506 Fig. 3c), or an only partially successful attempt to remove or dull the protuberance. There is no notch edge rounding and the bright, luminous polish is restricted to the notch edges. Nor do the wear traces extend beyond the notch. The notch wear shows a sequencing of striations first perpendicular to the notch and then parallel, and crystallization filaments on the left. So the final tool stroke was right-to-left and into the notch, or what might have been a grooving stroke for first girdling and then snapping the worked material.

The latter tool was a wedge, and would have been hand-held. Its microscopic use-wear is intermediately developed and has striations parallel to the longitudinal axis of the blade. These are directly associated with bipolar scarring of the ventral surface at the distal

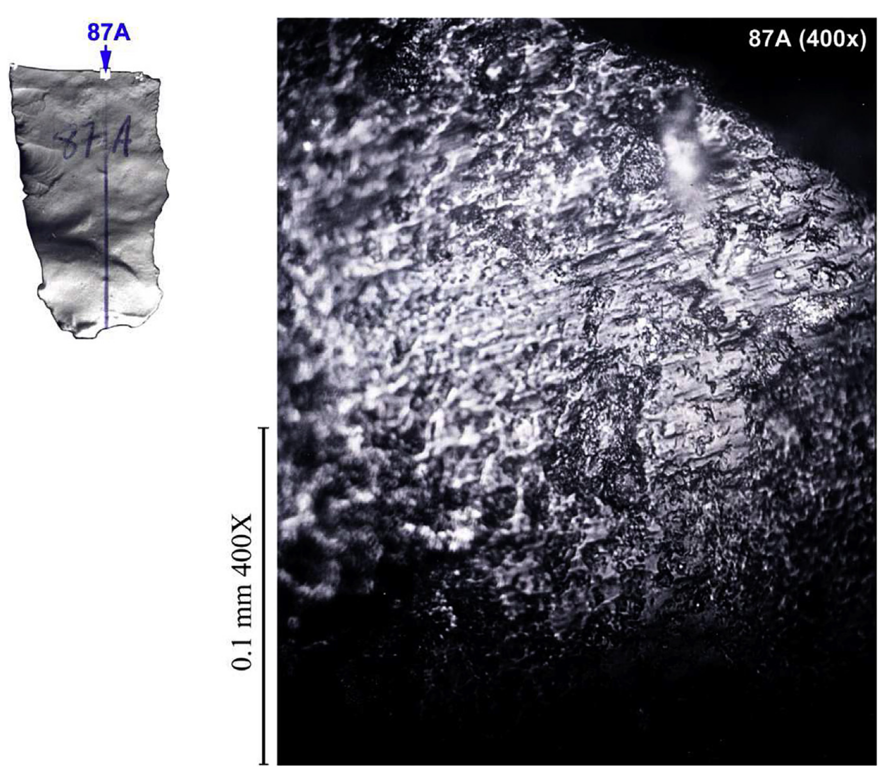

Fig. 26. Oriented photomicrograph for scraping medium hard contact material, ventral side of Pinson Mounds bladelet 87. Note lack of edge rounding. The greater density of obliquely oriented striations than in Fig. 25 records an earlier left-to-right scraping motion followed by one right-to-left.

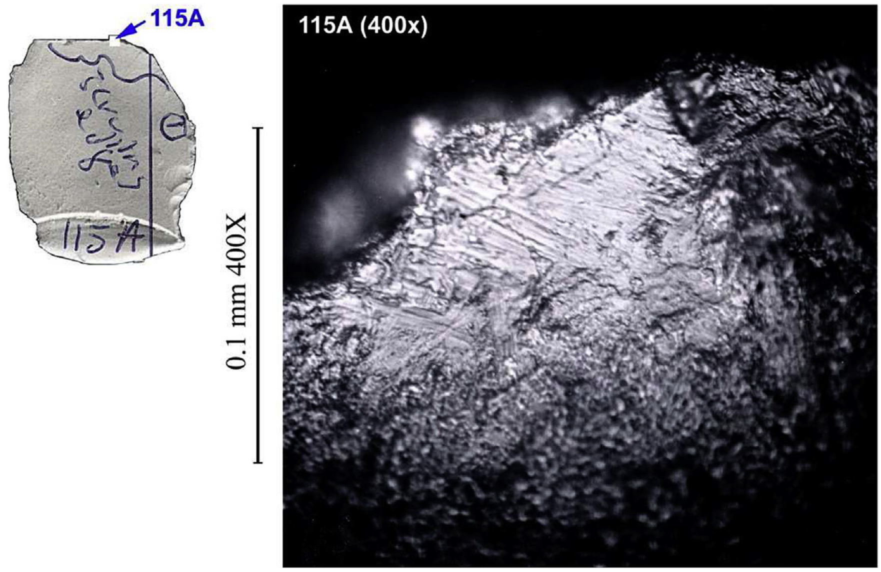

Fig. 27. Oriented photomicrograph for scraper plane used on medium hard contact material, ventral side of Pinson Mounds bladelet 115.

end, the wedge edge which has an obtuse angle (110°). The proximal end is a broad striking platform and is flat. Pitting on the margins of the striking platform on the ventral surface followed detachment of the blade from its prismatic core, and is distinctive of hammer impact. This would have caused the bipolar scarring on the opposite distal edge and would have likely been a source of the abrasive particles that caused the microscopic striations.

5. Implications

Although other models are possible, the most plausible and easily defended production chain for prismatic blade technology at Pinson Mounds addresses the burins. Burins were not necessarily at the center of this technology. But rather, their relative archaeological visibility is greater than any other prismatic blade tool, because they often failed and left a more inclusive record. What comes as a surprise is just how complete and, by inference, dynamic this record is. It begins not with burins as formal types per se but instead as terminal points in a longer tool production chain. So what we see first is something that does not meet objective, formal criteria of burins even when most useful at Pinson Mounds. Indeed, our search for burins finds them in strange and unexpected places. Among them, they are hidden with the whole prismatic blade gravers, knives, and scrapers. And they would not have been recognized at all were it not for the compelling use-wear evidence, even when the right or obtuse angled burin tool edge is not present. This changes our perception of what a burin is at Pinson Mounds. It shows that their initial use as burins preceded the now-recognized form, and allowed for recycling as other tool types or discard as debitage.

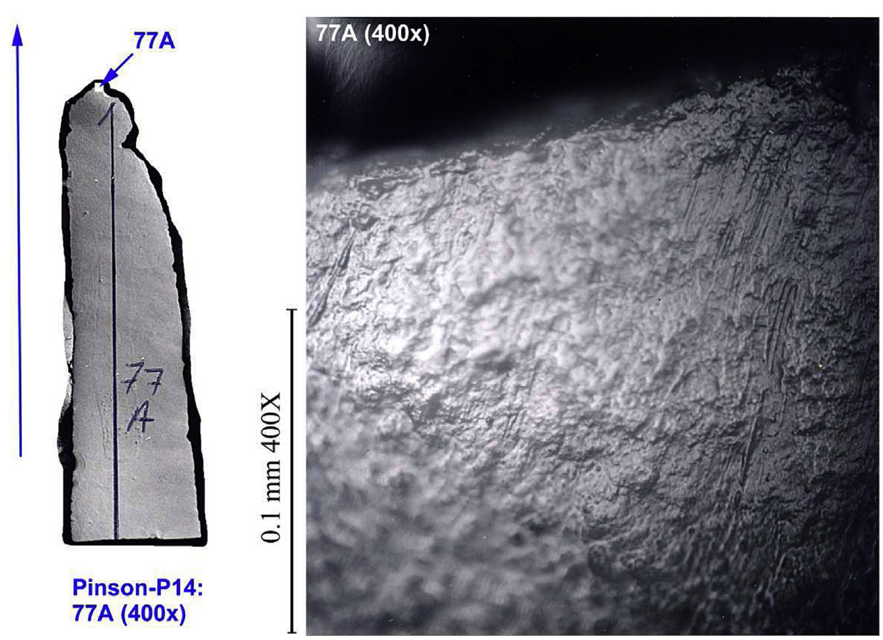

Fig. 28. Oriented photomicrograph of possible haft wear, ventral side of Pinson Mounds bladelet 77 distal fragment.

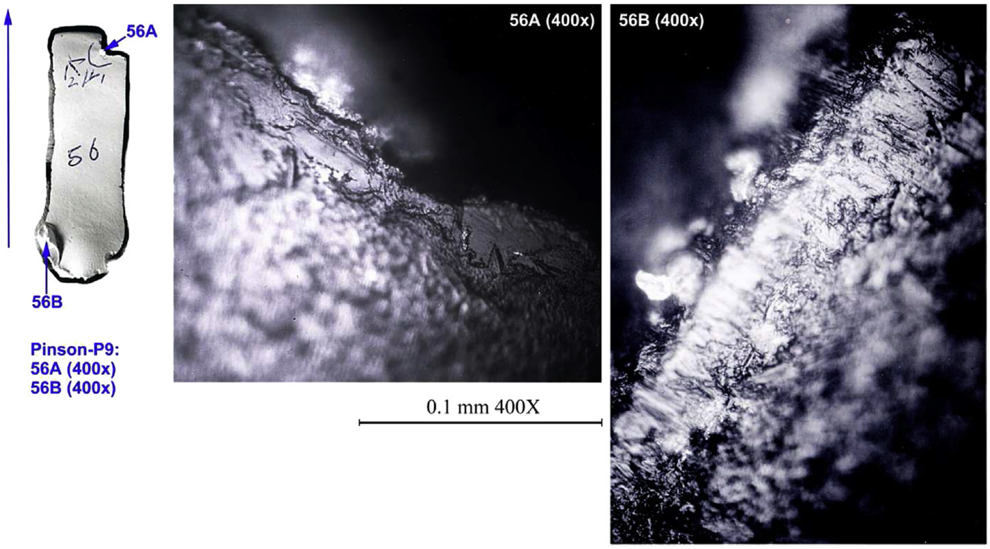

Fig. 29. Oriented photomicrographs of notch use-wear (56A) and haft or prehension (56B) wear, ventral side of Pinson Mounds bladelet 56.

In brief, the key elements of the burin production chain at Pinson Mounds (Fig. 30) are: first, transitional whole blades of several functions; second, the subsequent desired burin end product plus continued blade repair by radial fracture or snapping; and, third, either recycling of spent burins or discard. This production chain accounts for the prismatic blades from Pinson Mounds save the occasional oddity—the wedge or perhaps the notched girdling tool. More important is the explicit recognition of blade sharpening as integral to the longevity of prismatic blade tools from Pinson Mounds and consequent blade length parameters that governed retention. Blade repair by radial fracture or snapping is the only type identified unambiguously at Pinson Mounds. Intentional prismatic blade lateral edge retouch was not a factor either in making the initial tool edge or in its repair regardless of tool function. No matter the tool type or positioning of its edge, blade length was the crucial engineering design factor. If as was true for some knives and scrapers the tool took advantage of a lateral edge, it was the length and potential curvature of the edge that made the tool either good or bad and potentially allowed for hafting of the opposite edge. The point at which most prismatic blade tools were no longer repaired is a blade length less than 16 mm; the range of lengths where repairs would be less likely but still done, from 16 mm to about 26 mm.

Prismatic blade tools are more-or-less standardized forms that allow for many functions. The trick is figuring out not just the central tendencies but also the extremes in acceptable tool variation. Applied to Pinson Mounds burins, the tool edge angle is a useful guide (see Fig. 7). At the extreme ends of tool performance would be burin edges with acute angles (respectively for one tool each at 30°, 40°, 60°, 75°, 80° and 85°) and obtuse angles perhaps greater than 120°. Burin edges at the lower end of the acute angles (<60°) would be both especially vulnerable to breakage and easily overlooked, if whole and absent a use-wear evaluation. The large obtuse angles suggest an edge too broad to be effective for either gouging or slotting, insofar as the one wedge from Pinson Mounds has a (splitting) edge of 110°. The optimal burin edge, or central tendency, would seem to have been at the high end an obtuse angle (115° or less) and at the low end the far more common right angle. Compared to total length, the central tendency for burin edge angles more clearly defines this optimal range (Fig. 31) as burins were sharpened (repeatedly?) by snapping an end of a prismatic blade. The smaller burins record a better estimate of the desired burin edge angle, because they are less likely to have been subjected to further repair and only limited use. The reduction in burin blade length on sharpening is mostly accompanied by an even narrower tool edge angle range of between 90° and 100°. The acute burin edge angles likely were regarded as only minimally acceptable, as greater efficiency and less edge damage in either slotting or gouging occurs with the right or obtusely angled edge. The engineering design of these tools must have recognized tool edge failure as expectable, easily corrected by sharpening, and limited only by blade length; the longer the blade the longer the use.

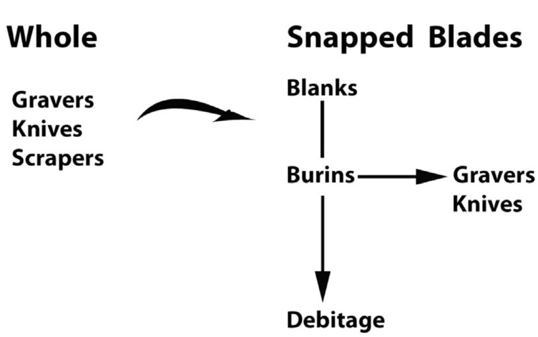

Fig. 30. Prismatic blade production chain focusing on burins for Pinson Mounds.

Prismatic blade tool repair by radial fracture or snapping does not require great skill or a specialist. It could have been done by most users, even were they not the ones who made prismatic blades, on pretty much a daily basis or as circumstance dictated. This would have been one of the advantages of this technology at Pinson Mounds. There would not have been an anticipated, prolonged period of downtime set aside for prismatic blade tool edge repair.

At Pinson Mounds this technology would have produced a range of manufactured goods mostly of wood, bone, antler or similarly hard substances. To this extent, the prismatic blade technology overall satisfies the criteria of maintenance, or fabricating, tools and to a far lesser degree extractive tools used in the procurement of resources (Binford and Binford, 1966).

The technology itself was a maintainable one (Bleed, 1986) in which repair would have been easy with little anticipated downtime and usage would be by non-specialists.

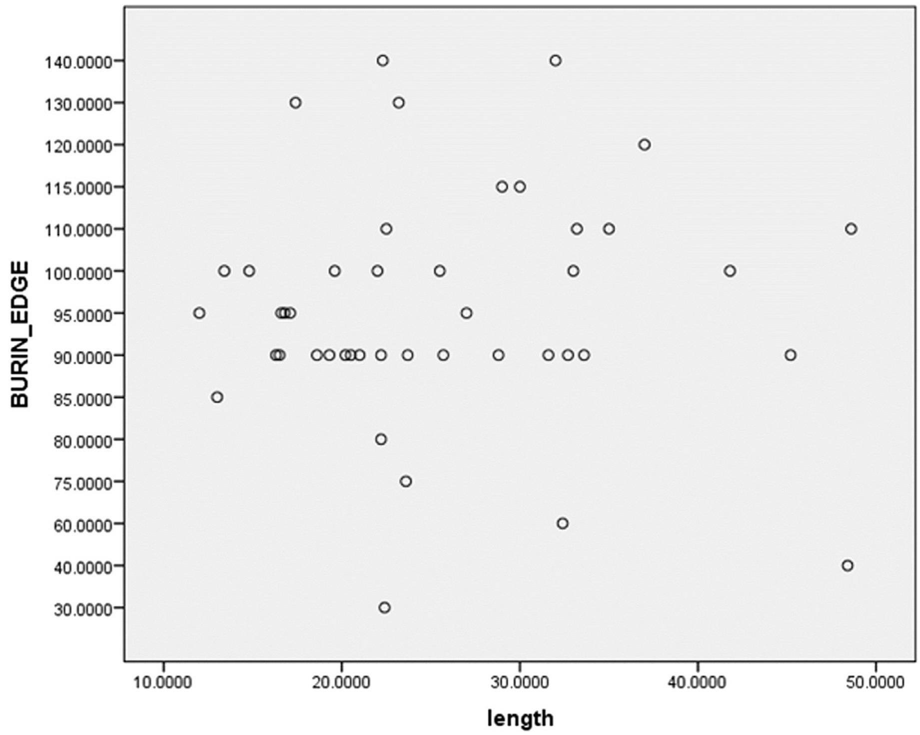

Fig. 31. Burin and related tool edge angles (see Fig. 7) in degrees compared to total prismatic blade length in millimeters.

6. Interpretations

Prismatic blades from Pinson Mounds and other Hopewell sites in the Midwest and Southeast United States were simple, easily repaired, modular tool forms of variable usage. Their production conserved toolstone to an exceptional degree, as a single prismatic core was well suited to the manufacture of scores- to hundreds- of similarly sized, razor sharp lamellar flakes. These often required no further modification for use. And when damaged or dulled, they could be renewed or recycled by unifacial retouch of a lateral edge or by radial fracture to create a durable but sharp snapped end. Their widespread occurrence stands as mute testimony of the high regard accorded to prismatic blade technology by Hopewell societies throughout the Eastern Woodlands of North America. From strictly an engineering design perspective, prismatic blade technology would seem to be among the most effective ways to manufacture and maintain chipped stone tools. Yet, when we look at their occurrence in the Eastern Woodlands of North America, we see a record of waxing during the Middle Woodland (and having been distinctive of Hopewell) and subsequent waning in the Late Woodland, only to be resurrected during the Middle Mississippian of late prehistory. Given that prismatic blade technology did not remain popular but actually ceased to exist when the Hopewell culture climax (Griffin, 1967) ended, it seems fair to ask why.

We (and others – notably Byers, 2004:227–239; Hall, 1997:155–156; Morrow, 1987:145–148) think the answer must lie not in the technology per se but in the culture or societies that made up the Hopewell world and experience. The reason we have abandoned a strictly technological explanation is the standardization in tool forms evident in Hopewell prismatic blades does not equate to a similar standardization in tool function, or to a specialized context in which these artifacts are found (see also Miller, 2014; Yerkes, 2009). Rather, these prismatic blades are analogous to a modern day screw driver or paper clip whose understood purpose does not eliminate other creative and productive ways to use the tool. If anything, what seems true at Pinson Mounds and elsewhere is a built in *anticipation* of tool recycling. This would have extended the use lives and potential utility of the prismatic blades instead of having been a slavish adherence to a single tool form and function. Thus, a modular tool form useful for many functions with little or no further modification must have been the key to the engineering design of prismatic blades.

What seems to have been most attractive to Hopewell makers and users of prismatic blades was a shared concept of their manufacture combined with preferential access to often distant sources of toolstone. For Pinson Mounds and sites in east Tennessee and North Carolina (see Kimball, 1992), at least, the social connection of particular note is with toolstone sources in the Ohio River valley and its tributaries. The inescapable conclusion is that inherently social means were essential to configure technology rather than technology dictating social process. That, in essence, is at the heart of the Hopewell Interaction Sphere. At its core the Hopewell Interaction Sphere communicated information about social identity and status, and did so in tangible ways still partially knowable today.

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